AHRQ Technical Assistance Project: Feasibility of Environmental Interventions for Asthma

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Rhode Island Department Of Health

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Dear Rhode Islanders:

It is with great pleasure I present to you the *AHRQ Technical Assistant Project: Feasibility of Environmental Interventions for Asthma Agency for Healthcare Research and Quality.* This report provides an overview of the infrastructure of the Lead Centers in Rhode Island, and gives recommendations on how this successful model could be replicated to reduce disparities in pediatric asthma through the development of 'Asthma Centers'.

The Rhode Island Department of Health is committed to reducing the burden of asthma. It is with great hope that our community and state partners are able to use this valuable information as we work together to address asthma management among one of Rhode Island's most vulnerable populations, children.

Sincerely,

David R. Gifford, MD, MPH
Director of Health

Acknowledgements

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Authors

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TABLE OF CONTENTS

Section....Page

Executive Summary....1

Introduction....11

Stakeholder Interviews....13

Literature Review....17

Rhode Island Lead Center - Capacity Assessment....29

Pilot Project Design....41

Appendices....61

- A. Rhode Island Lead Centers Case Loads, 2006....61
- B. Chronology of project-related meetings and conference calls....65
- C. Additional resources....69
- D. Data request to RIte Care Health Plans....73
- E. Rhode Island Agency for Healthcare Research and Quality Team Members....77
- F. Rhode Island Asthma Control Coalition Members....81

EXECUTIVE SUMMARY

INTRODUCTION

In Rhode Island, a significant public health and housing resource network has been built in order to treat and prevent lead poisoning among children. An important element of this model includes the state's Lead Centers, which provide case management and coordination of housing inspection & remediation services. Lead Centers are funded through the state's Medicaid program. In Rhode Island and throughout the country, some efforts by individual agencies to assist families with in-home asthma trigger reduction have failed because of the complexity of the problem and due to inadequate funding required to maintain services. As lead poisoning rates in RI decline, Lead Centers will have excess capacity and crossover assets to serve families with asthma (case workers, experience with landlords, funding mechanism, etc). Medical treatments for asthma are also more complex and adherence to medical plans is a major factor in successful asthma management.

This report explores the potential for operational expansion of the current Lead Centers into a business model that includes working with families with asthma. Such a transition requires an understanding of asthma etiology and medical treatment guidelines, environmental intervention models and operational challenges. This report includes a summary of nationally published literature on the effectiveness of environmental interventions for asthma, an overview of current Lead Centers operations, and an outline of a pilot program designed to test the efficacy of Lead Center expansion for asthma.

The implementation of a pilot program to test a statewide model for asthma interventions will require the participation of numerous stakeholders. Rhode Island has many resources, public and private, that have worked together on improving the health of asthmatics. An example of this collaboration is the Rhode Island Asthma Control Coalition, which includes representatives from the Rhode Island Department of Health (HEALTH), hospitals, community health centers, health plans, non-governmental organizations and community action programs. The specific design of the pilot program would be determined by external considerations, such as funding availability, staffing, in-kind contributions and other commitments from stakeholders. The information presented here is intended to provide the framework for the design process, to be constrained by available resources.

It is important to recognize that the current scope of the asthma problem in Rhode Island is larger than that associated with lead poisoning, based on the population affected. For example, in 2006, there were 208 cases referred to the four active Lead Centers (Source: HEALTH, CLPPP, LESS database, K. Truong personal communication). Approximately 56% of these cases were RIte Care patients and 44% were Non-RIte Care patients. In contrast, according to a 2007 HEALTH report:

- An estimated 1 in 10 adults (9.6 percent) aged 18 and older currently have an asthma diagnosis (current asthma)
- An estimated 1 in 10 children (10.1 percent) under the age of 18 currently have an asthma diagnosis (current asthma)

These prevalence rates were supported by a 2006 report (ARC, 2006) showing that the lifetime asthma rate for adults in Rhode Island was 14.6%. Therefore, the scale of the problem limits the ability of the Lead Centers to fully absorb case management duties for the affected population. However, careful program design can allow the Lead Centers to serve those most in need or those for whom case management or environmental interventions will provide the greatest benefit.

The following overview of our findings is divided into the following sections:

1. Key Strengths
2. Challenges
3. Critical Needs

Key Strengths

Based on several key core competencies, the existing Lead Centers are well positioned to augment their existing responsibilities with programs designed to address asthma morbidity. Specifically, these competencies include their ability to:

Track case families Making initial contact with case families and maintaining this contact throughout a follow-up period of months to years can be especially challenging within low-income populations. Many households are in rental housing, move frequently, may not have phone service and may be reluctant to be contacted by agency representatives.

Work with low-income, multicultural populations Effective case management requires establishing trust between the community health worker and the recipient of services and maintaining clear communication, especially among low-income populations.

Conduct environmental inspections The current system to address residential exposures for significantly lead poisoned children in Rhode Island offers comprehensive environmental lead inspections. While inspections for asthma-related residential risks need to address numerous pathways, this institutional understanding of housing as a determinant of health is critical.

Interact with relevant agencies and agents Housing interventions aimed at reducing lead exposures often require communication and coordination between numerous players, including local officials responsible for housing code enforcement, private landlords, contractors and public housing authorities. Local housing codes are notoriously varied, which may require increased coordination with the relevant code officers. This interaction will be especially important for the variety of potential asthma interventions.

Make referrals Connections with needed services to address problems that may be interfering with families' abilities to focus on health issues are needed (social work model).

Challenges for transition

Uncertainties concerning co-morbidity of lead poisoning and asthma While both lead poisoning and asthma are elevated among children living in poverty, it is unclear whether there is significant overlap between the housing stock and household behaviors that contribute directly to these conditions. More than 80% of children in the U.S. with blood-lead levels above 20 μg/dL are eligible for Medicaid. While the association between low socioeconomic status and asthma is strong nationwide and in Rhode Island, the extent of co-morbidity within households has not been fully explored. As part of a pilot testing phase, the extent of overlap could be estimated using HEALTH data and records from the RIte Care health plans.

Staffing and training The current staffing of Rhode Island's lead centers provide many of the core skills necessary for managing an asthma intervention program. However, this staffing would need to increase in both size and scope. The development of training programs that address the pathophysiology of

asthma, as well as its clinical and environmental management would be necessary. In general, staffing needs would need to shift toward a clinical case management model, where treatment guidelines are used to provide a primary assessment of the child's health and benchmarks for follow-up. Asthma treatment guidelines established by the National Heart Lung and Blood Institute, as well as guidelines for the environmental management of pediatric asthma developed by the National Environmental Education and Training Foundation, would serve as a model. Staffing requirements would need to be based on the "program standards" defined by the new program.

These needs are significant, given that the existing Lead Centers have experienced difficulties surrounding training. These centers have cited communication issues with DHS and DOH as challenges to start-up. In our discussions, it was suggested by the Lead Centers that they should meet on a more frequent basis (e.g. monthly) to share experiences and challenges among themselves, and meet less frequently with the state agencies, DOH and DHS (e.g. quarterly).

Current staffing at the existing Lead Centers does not provide much excess capacity. However, given the projected reductions in caseloads, additional capacity will be available. According to HEALTH goals, the number of lead poisoned children (BLL>10μg/dL) is expected to be reduced from 621 at the end of 2005 to 120 at the end of 2010. This excess staffing capacity should be sufficient to sustain a targeted asthma program (caseload ~200). Intervention and evaluation costs may require additional funding

Enforcement issues Lead poisoning is a health problem with a significant legal mandate, reflected in public health regulations and housing codes. Asthma-relevant risks within the residential environment, however, are not fully reflected in current regulations at the federal, state or local level. Code enforcement, therefore, may not provide incentives for private parties to make recommended improvements.

Case definitions Most asthma programs that track or manage asthma morbidity struggle to establish case definitions that are robust and reliable. Due to the high asthma prevalence rates observed in recent years, intervention programs must focus efforts on a subset of diagnosed cases, based on disease severity or opportunities for improvements. For example, according to a 2007 HEALTH report, an estimated 10 percent of children in Rhode Island have asthma. (HEALTH, 2007). Therefore, the potential "market" for asthma interventions is much larger than that for residential lead poisoning.

Several options exist for focusing these efforts. Within the clinical setting, treatment guidelines typically use symptom frequency to define disease severity. NIH guidelines have established a classification system for asthma severity that assigns a patient to one of four categories:

- Mild Intermittent
- Mild Persistent
- Moderate Persistent
- Severe Persistent

Within the individual RIte Care health plans, performance measures developed by the National Committee for Quality Assurance (NCQA) are frequently used to approximate these severity scores. These measures, part of the Health Plan Employer Data and Information Set (HEDIS), identify persistent asthmatics according to asthma healthcare utilization.

Healthcare utilization is likely to be a key factor in targeting patients for interventions. It has been estimated that 20% of asthmatic patients are responsible for 80% of the medical resources used to treat the condition. (Smith DH, et al.1997) Selection of intervention candidates from a pool of "high-utilizers" identified through the RIte Care plans may be the best approach to test cost-effectiveness of the program. A framework for identifying children with persistent asthma within the RIte Care health

plans could be modeled on the current system of identifying children in need of lead screening. Since 2002, the Rhode Island Childhood Lead Poisoning Prevention Program (RI CLPPP) has worked closely with these health plans to identify children who have not been screened.

Environmental inspection protocols These will need to be expanded to reflect current knowledge on observable indicators of asthma risk. These inspections also serve as opportunities for patient or household education on avoidance of asthma triggers.

Exposure uncertainties Exposure pathways for residential lead exposure are well established. Asthma exacerbations, however, are driven by environmental exposures that vary widely across residential settings, are often difficult to quantify, and interact strongly with the patient's underlying susceptibility. Action thresholds for elevated blood lead levels have been established to guide decisions on the need for intervention. While empirical evidence has suggested that exposure thresholds for allergen sensitization and exacerbation may exist, collection of the necessary environmental samples may not be practical or cost-effective. Therefore, simplified screening tools and monitoring techniques should be employed. For example, pest infestation can be monitored using simple questionnaires and the use of household traps deployed at regular intervals.

Sampling and data analysis Creating a system for the collection, tracking and analysis of key environmental samples may be necessary. Laboratory services may be conducted by state-run or state-certified labs as necessary. Up until June 2007, the HEALTH laboratory tested environmental samples (e.g., dust wipes, soil, paint) for the lead program. The potential capacity to handle environmental testing relevant for asthma, such as testing for mold (surface, airborne and bulk samples) and allergens (airborne or vacuum dust) is not clear currently.

Need for tailored interventions Basically, one size does not fit all. Most environmental interventions aimed at reducing asthma morbidity focus on reducing the subject's exposure to triggers. The most important triggers are indoor aeroallergens, such as those associated with dust mites and cockroaches, which can contribute to pulmonary inflammation in sensitized individuals. Therefore, reductions in these specific exposures may not be effective for all asthmatics.

Allergic sensitization can be determined using clinical history, skin-prick testing and RAST methods (blood-based allergy test). While allergy testing is typically covered by health insurance, it is performed infrequently in low-income populations. Options for incorporating allergy testing into the intervention design procedure must be considered to maximize efficiency. These options may include discussing allergy testing with the patient's primary care physician, or direct referrals.

Intervention costs Most asthma intervention programs do not fully address environmental exposures. Typical models focus on medical management, patient education and, frequently, the distribution of low-cost durable goods. These goods include supplies that aid in the daily self-management of the disease (e.g., peak flow meters) or those that can be used to address allergen exposure (e.g., mattress covers). However, a wide range of effective options exists, from those with nominal costs (under $25) and minimal effort to those requiring physical remediation of the home and considerable cost (e.g., extensive mold damage). Packages of environmental interventions that have been used in successful asthma programs can cost in excess of $1,500/subject.

Clinical management Asthma interventions programs need to be centered on a clinical case management model where, to the extent possible, it will be critical to insure proper diagnosis, treatment and medication adherence, prior to any environmental intervention.

Contracting for intervention-related services As stated above, environmental interventions for asthma include a wide range of options. Problems such as extensive mold damage and pest infestation would

require the expertise of contractors. Hiring and managing contractors for this type of work requires its own expertise. Household repairs, elimination of pest infestation (preferably through Integrated Pest Management), mold remediation, and appliance replacement would all require established protocols for referrals and contracting.

Identification of existing programs Some of the necessary infrastructure for interventions may already exist. Existing public programs or the private sector may provide funding for interventions. For example, most housing codes require that landlords control pest infestation, which may allow for resolution through code enforcement mechanisms. Also, smoking cessation programs for household members may be covered by their respective health plans.

Critical Needs

Establishment of a statewide advisory board This board, representing key stakeholders, would serve to provide guidance on the design and evaluation of an asthma intervention program. This may fall under the auspices of the Rhode Island Asthma Coalition.

Funding Funding needs for a statewide asthma intervention program may be substantial. Therefore, the scope of any program would need to be established based on these resources. Possibilities include federal and state funding, RIte Care health plan covered services (new and existing), RIte Care health plan initiatives, private foundations and private initiatives.

Case definitions A group representing RIte Care health plans and asthma clinicians should be convened to establish a reliable case definition to be used for tracking and intervention eligibility. This is especially important for defining a control population that can be monitored concurrently with those participating in any intervention.

Determination of scope of interventions An environmental "prescription" to alleviate asthma symptoms could include anything from the distribution of a mattress cover to a whole-house mold remediation. Obviously, these interventions differ greatly in cost, effort and the expertise needed to achieve success. All of these may be considered in defining the "toolbox" or "menu" of intervention options. In establishing guidelines for what may be 'covered' in a home intervention program, there may be a preference to maximize long-term effectiveness by focusing on household products and household behavior, rather than the home's physical condition, due to the residential mobility of many RIte Care members.

Integration of existing RIte Care case management programs The three RIte Care health plans have established case management programs for asthma. While these programs vary in selection criteria, scope of services and staffing, they all recognize the importance of integrated approaches that include: medical management, patient education and promoting strategies that reduce household environmental exposures. Incorporating the lessons learned from these programs will be essential.

Establishment of a tracking system for intervention recipients It is critical that any program include a carefully designed plan for tracking intervention subjects and 'control' populations. A control population is necessary to separate "true" intervention effects from other factors, such as changes in: true asthma incidence, healthcare utilization patterns, and population demographics. A control population would most easily be drawn from the RIte Care Health Plans, perhaps defined as those members meeting the case definition (and thus, eligibility for intervention), but who have not received the intervention, due to recruitment difficulties or case loads.

There is a need for standardization of protocols, forms, and databases used by any new program. Tracking systems need to measure various measures of the program's success, which may include:

- Healthcare Utilization
  - Emergency department visits
  - Hospitalization
  - Pharmacy Claims
- Patient knowledge and behavior
  - Patient knowledge (e.g., trigger avoidance, medication use)
  - Asthma Action Plan compliance
- Self-reported symptoms

Healthcare utilization could be tracked within the RIte Care system. However, patient knowledge and behavior and self-reported symptoms can only be tracked through surveys administered to subjects directly. Therefore, the collection of this information from a control population may not be feasible.

Design of Pilot Program Overall, the implementation of a pilot program to test a statewide model for asthma interventions will require the participation of numerous stakeholders. Several steps, including several highlighted above, would be required to design a pilot program:

1. Identification of Target Populations
2. Determination of Case Definitions
3. Design of Tracking Systems
   - Subjects
   - Environmental Conditions
   - Outcomes
     - Healthcare Utilization
     - Patient knowledge and behavior
     - Self-reported symptoms
4. Determination of Staffing and Training Needs
5. Development of Screening Tools
6. Design of Interventions
   - Case Management framework
     - Medical Management
     - Home Visits
       - Surveys
       - Visual Inspection Protocols
       - Environmental Sampling Methods
       - Protocol for return visits
     - Coordination with and utilization of existing programs

- Environmental interventions
  - Determination of scope
  - Susceptibility-exposure links
  - Design of decision matrix

These considerations are discussed in the report. Briefly, a pilot program would be built on a model of in-home environmental case management that will provide education, as well as durable goods and services aimed at trigger mitigation in the home.

The program would provide in-home case management and services to remediate asthma triggers to 200 families, who will be tracked over a one-year period from the initiation of intervention. Of these families, 100 will receive an enhanced package of durable goods and services (see Table 1-1), based upon proven models, including those employed in the Inner City Asthma Study. Both intervention groups will receive up to three home visits conducted by community health workers. During the initial home visit, a visual inspection will be performed to identify potential triggers. An individualized home intervention plan will be developed for each subject based on his or her risk profile. Interventions for the enhanced group will include additional goods and services. For each intervention, a decision matrix will be developed that utilizes information from each patient's medical history, diagnostic tests (e.g., skin prick testing, where available), survey data and environmental sampling to determine eligibility. Follow-up visits will track progress and provide additional education or assistance.

Table 1-1: Potential intervention activities by intensity level

Components	Basic	Enhanced*
In-home education and case management	✓	✓
Mattress + pillow covers	✓	✓
Pest management supplies (roach baits, rodent traps)	✓	✓
Smoking cessation (referral if covered)	✓	✓
HEPA vacuum	-	✓
HEPA air cleaner	-	✓
Integrated Pest Management program	-	✓
Home repairs	-	✓
Mold remediation	-	✓

* potential interventions are listed – for each subject, selection of components will be customized.

As shown in Table 1-2 costs for more intensive interventions can be considerable. Existing studies have shown that effective programs can cost in excess of $1,500 per home, resulting in direct intervention costs in excess of $150k for a pilot program.

Table 1-2: *Approximate* Costs for Asthma-relevant Home Interventions

Intervention	Cost	Cost Variability
Mattress + pillow covers	< $100	Low
Air cleaner (HEPA)	$100-200	Low
HEPA vacuum	$100-200	Low
Smoking cessation	Up to $1000	Med
Food storage containers	< $50	Low
Mattress replacement	$300+	Low
Minor repairs	$200-$500	High
Mold/moisture remediation	$200+	High
Targeted repairs – pest access	$200+	High
Combustion appliances – removal/replacement	$500+	Med
Home cleaning	$200-$1000+	High
Integrated Pest Management contractor	$200-$1000+	High

Subjects for the pilot program should be drawn from RIte Care membership. Drawing from a single health plan (e.g., Neighborhood) will likely ease implementation and facilitate tracking of claims. Similarly, building the pilot program from a single Lead Center will ease implementation, allowing for centralized staffing, training and management of intervention activities. Based on current caseloads at RI Lead Centers, additional staffing would be required to implement the pilot program. This staffing would, at a minimum, include 2-3 full-time positions. One of these positions should be filled with a person with significant clinical experience, preferably in asthma case management. St. Joe's Lead Center is best equipped currently to manage an expanded program. The costs associated with this staffing increase will exceed $100k/yr. For each additional 100 subjects/year, 2-3 full time staffers would be needed to support this caseload.

Case management for lead poisoning typically continues for a period of time sufficient to complete an intervention and achieve reductions in measured blood lead levels. Asthma, however, is a complex disease that, while it can be effectively controlled in many cases, is a chronic condition that cannot be cured. This limits the choices for an objective endpoint. Therefore, appropriate enrollment periods for any asthma program should be sufficient to establish baseline assessments, perform interventions and monitor outcomes over a timeframe that allows for stable estimates of key outcome data. Given the significant seasonality of asthma and the infrequency of certain outcomes, such as hospital stays and ED visits, case management should continue for a minimum of 12 months. In general, a fee-for-service model may not work for asthma, since it is a chronic condition. The ultimate question is "At what point do you decide to close a case?" Clear case definitions and closure rules are needed to answer this question. The current reimbursement structure for lead is not efficient since there is incentive to drag out case management to increase the amount of reimbursement per case (given they are paid by the day, up to a cap).

If budgetary restrictions do not allow for the enrollment and tracking of 200 subjects, interventions should be focused on a mix of 'basic' and 'enhanced' interventions for 100 families. A control population should be drawn from RIte Care membership, which would allow for the collection of utilization data. (Operationally, selecting 250 subjects from RIte Care membership and randomly assigning 125 subjects to receive interventions could accomplish this. The excess enrollment would allow for some loss to follow-up.)

The program should be structured to assess the effectiveness of the enhanced environmental

intervention program through comparison of claims data, symptoms, quality of life and (potentially) allergen levels in the home. This will allow the State to conduct an objective program evaluation and make modifications as necessary.

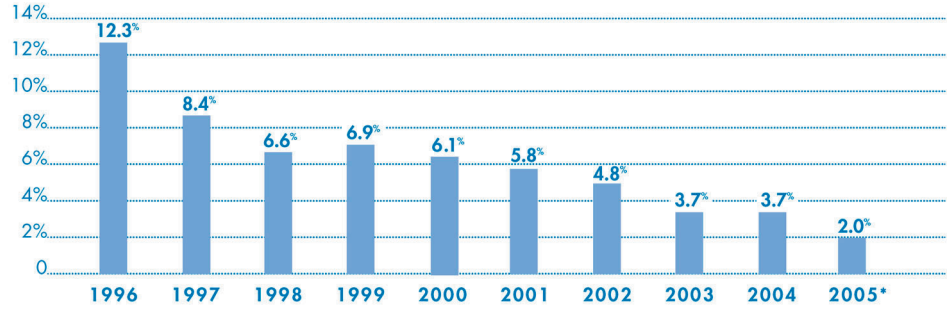
Reference

Smith, D., D. Malone, K. Lawson, L. Okamoto, C. Battista and B. Saunders: 1997, A National Estimate of the Economic Costs of Asthma, American Journal of Respiratory and Critical Care Medicine 153.

INTRODUCTION

In Rhode Island, significant efforts have been made to treat and prevent lead poisoning among children. An important element of this model includes the state's Lead Centers, which provide non-medical case management and coordination of housing inspection & remediation services. Lead Centers are funded through the state's Medicaid program. In many instances throughout the country, efforts by individual agencies to assist families with in-home asthma trigger reduction have failed because of the complexity of the problem and due to inadequate funding required to maintain services. As lead poisoning rates in RI decline (see Figure 1-1), Lead Centers will have excess capacity and crossover assets to serve families with asthma (case workers, experience with landlords, funding mechanism, etc).

Figure 1-1: Incidence of Lead Poisoning in Rhode Island, 1996-2005*



** Data reported for 2005 are based on venous tests and confirmed capillary tests only.*

This report summarizes our efforts to assess the feasibility of expanding Lead Centers to begin working with families with asthma. Key sections of this report, prepared according to the Scope of Work approved by the Agency for Healthcare Research and Quality (AHRQ) are described below:

Section 3 – Stakeholder Interviews: Summary of interviews with representatives of key stakeholders within the State, including the Lead Centers and the three primary Rhode Island Medicaid (RIte Care) health plans: Neighborhood Health Plan of Rhode Island, United Healthcare of New England and Blue Cross and Blue Shield of Rhode Island.

Section 4 – Literature Review: A review of the scientific literature on the use of home environmental interventions to reduce asthma morbidity.

Section 5 – Capacity Assessment of Lead Centers: An assessment of the current operations of the Lead Centers, as well as their capabilities of to begin asthma services.

Section 6 – Pilot Intervention Proposal A discussion of the components of a pilot intervention that would help HEALTH answer critical questions about the efficacy and cost-effectiveness of environmental interventions in managing asthma.

*Rhode Island Department of Health. (2006). Childhood lead poisoning in Rhode Island: The numbers 2006 edition. Providence: Rhode Island Childhood Lead Poisoning Prevention Program.

STAKEHOLDER INTERVIEWS

A series of interviews were held between October 2006 and May 2007 with key stakeholders within the State, including the Department of Human Services, the Lead Centers and the three primary Rhode Island Medicaid health plans (Neighborhood Health Plan, United Healthcare and Blue Cross and Blue Shield). These interviews were used to shape our assessment of the needs and opportunities for expansion of asthma programs in Rhode Island. Health plan interviews were used to obtain information on their use (if any) of environmental interventions in the management of asthma and to document the scope of such services and their associated costs.

Lead Centers

The interviews with Rhode Island Lead Centers were used to develop Section 5 of this report. Please refer to that section for details on the information gathered during those sessions.

Health Plans

The three Rhode Island Medicaid (RIte Care) health plans participated in these discussions: Neighborhood Health Plan, United Healthcare and Blue Cross and Blue Shield). These discussions focused on each plan's experience in managing asthma within their membership. Detailed information on the costs of these programs was not provided during these discussions.

Summarized below are the recent efforts employed by these plans to manage asthma for their members:

NEIGHBORHOOD HEALTH PLAN OF RHODE ISLAND

More than 50% of RIte Care members are enrolled in Neighborhood Health Plan of Rhode Island (NHPRI). NHPRI, which was founded by a group of community health centers that serve low-income populations throughout the state, has recognized the need to address asthma for their members. *Beating Asthma* was a pilot intervention program implemented through NHPRI for patients with persistent asthma receiving primary care in communities with minimal asthma resources.

Patients selected for the program had persistent asthma, as defined by Health Plan Employer Data and Information Set (HEDIS) criteria. These criteria included claims evidence of one asthma inpatient admission or emergency department visit, or four asthma medication dispensing events, or four outpatient asthma visits and at least two asthma medication dispensing events.

All patients received the following:

- Home-based education (up to three sessions) conducted by bilingual, bicultural community health workers (CHW's)
- Referral to Hasbro Hospital's Draw a Breath program, which provides educational programs for asthmatics and their families
- Walk-through environmental assessments and recommendations for trigger control, including low-cost supplies for trigger reduction (e.g. mattress covers)
- Feedback to primary care providers through tailored reports

Families were recruited through physician and case management program referral. During the first visit, informed consent was obtained and families received education regarding the physiology of asthma, and the appropriate use of medications and medication delivery systems. In the second visit, the CHW's conducted an environmental assessment, including a walk-through evaluation of the home.

An analysis of claims data for this program (70 subjects) showed measurable improvements across several outcomes. (McQuaid et al., 2006) Patients demonstrated a marginally significant decrease in ED usage ($p < 0.1$). This was associated with a significant decrease in total costs for the group from $5,162 to $3,200. The average number of hospital days reduced substantially post treatment ($p < 0.001$), which was also associated with substantial cost reduction from $40,342 to $5,919 (again, total costs). Outpatient visits showed only a marginal decrease ($p < 0.10$). The average number of dispenses for beta-agonist medications decreased significantly from 2.61 to 2.03 annually ($p < 0.05$). In contrast, the average number of controller medication dispenses increased from 1.81 to 2.96 per year ($p < 0.001$). This increase in controller medications is consistent with improvements in care, as patients receive appropriate treatment and reduce their reliance on quick-relief medications.

UNITED HEALTHCARE OF NEW ENGLAND

United Healthcare has focused on a "high touch" care model, which incorporates more opportunities to interact with members through disease or case management.. United employs community outreach case managers who address various conditions, including asthma, diabetes, women's health, etc. At the time of our interview, they were transitioning from a team based in New York to a Rhode Island-based staff. Their disease management program for asthma (which is voluntary) is offered upon a health risk assessment at enrollment or following a review by case managers, based on claims data (ED visits, hospitalizations, etc.) In general, they have increased their emphasis on case management for their Medicaid population (they serve commercial and Medicaid populations).

Asthma patients in the program are assessed for severity. Mild cases receive educational information only (unless more is requested by parents). For more severe cases, United works with clinicians to decrease hospitalizations using various methods, including automated telephone reminders to patients. They plan to provide peak flow meters and spacers to their asthma patients.

BLUE CROSS AND BLUE SHIELD OF RHODE ISLAND

Blue Cross and Blue Shield of Rhode Island (BCBSRI) serves 14,000 RIte Care members (12% of total membership). They have initiated asthma programs since asthma is the number one reason for ED visits among their members. Also, Singulair, is their most prescribed medication and, in total dollars, accounts for the largest cost associated with a single medication. BCBS initiated their asthma case management program in July 2005.

Under this program, once each month BCBSRI identifies all RIte care members who had an asthma-related emergency department visit (ICD-9 493) during the past month. Using this algorithm, their response is timely, with the trade-off being that some claims are ultimately missed since 90 days are allowed for claim submittal. These reports are referred to case management, where nurses attempt telephone contact. As with many Medicaid populations, they have found that subjects can be hard to reach. BCBS has an outreach program for home visits staffed by nurses (their RIte Care outreach dept has 4 nurses). This outreach program provides:

- Asthma care education, focused on
  - Establishing an Asthma Action Plan
  - Proper use of medications
  - Asthma triggers, including ETS exposure
  - Other household exposures, including lead
- Free "spacers"
- Peak flow meters

- RIte Care member education (same as for high-risk pregnancies)
- The program does not provide mattress or pillow covers.
- Free asthma education classes offered throughout the state (9-12 per month) (Draw a Breath program, run by Hasbro)

They have observed decreases in ER utilization since program started.

Asthma trends and utilization data

In order to understand the potential challenges and benefits associated with implementing an asthma intervention program, it is important to understand trends in asthma incidence and the associated trends in utilization. While some summary data on these trends are available for Rhode Island, there were significant data gaps. For example, utilization trends by type of claim, which can capture recent increases in the costs of some asthma medications, were not available. Also, information on the distribution of claims within each plan, which would help quantify the issue of "high utilizers" within each plan.

Based on these needs, the components of a detailed data request were discussion during meetings with each health plan. These discussions resulted in a formal request, which was submitted to the each of the RIte Care plans on October 30, 2006 (see Appendix). Neighborhood Health Plan completed a partial completion of the data request in February 2007. However, this did not allow us to explore the specific issues discussed above and these data are currently not presented herein. We believe that this information is critical and we would support continued efforts to collect these data.

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LITERATURE REVIEW

Introduction

Over the past three decades, asthma prevalence has increased significantly worldwide. Asthma is currently the most common chronic disorder in childhood and adolescence**.** In the United States, among the approximately 20 million persons with asthma, about 5 million children under 18 years of age have the condition. According to the Centers for Disease Control and Prevention, the annual cost of asthma in the U.S. increased dramatically between 1990 and 2000, rising from $6.2 billion to $14.5 billion. Asthma hotspots have been reported in cities nationwide, where childhood prevalence rates among the urban poor can exceed 25%.

While definitive reasons for this increase are unknown, research efforts during this period have advanced our understanding of the etiology of the disease. While genetics plays an important role, it is unlikely to play the dominant role in the recent temporal trends. Many indoor environmental exposures are known to act as "triggers" for those with diagnosed asthma, as well as increasing the risk of disease development early in life. In general, it is critical to distinguish between "asthma development" and "asthma exacerbation" in any discussion of risk factors. Worldwide, asthma prevalence is highest in more developed countries or those classified as more "westernized," suggesting factors associated with lifestyles and exposures within these environments are important.

Asthma, like cardiovascular disease, is considered a 'complex disease' with multiple genetic and environmental risk factors contributing to an individual's overall risk. Genetics can be considered one example of "susceptibility factor" that plays an important role in determining risk (see Table 4-1).

Table 4-1:Potential Risk Factors for Asthma [modified version of (Yeatts *et al.*, 2006)]

Environmental Exposures	Susceptibility Factors
Biological exposures (indoor/outdoor) Allergens Endotoxins Pets Molds Chemical exposures (indoor/outdoor) Environmental tobacco smoke Nitrogen oxides Particulate matter	Genetics Age ("window of exposure") Obesity Smoking Diet Breast-feeding Lung growth

In addition to genetics, there is a large and growing body of evidence that links various indoor environmental exposures to asthma development and/or exacerbation (IOM, 2000). These include exposures to pest and pet allergens, environmental tobacco smoke, infectious agents, combustion by-products, chemical agents and pesticides. The role of specific indoor air exposures in contributing to asthma development and exacerbation were most recently reviewed in a 2000 report by the Institute of Medicine. This report documented the weight of evidence for each exposure (see Table 4-2). The strongest evidence links exposure to indoor allergens with asthma, including those associated with dust mites, cockroaches and cats. It is therefore assumed that avoidance of many of theses agents, where possible, is prudent.

Table 4-2: Summary of the Institute of Medicine Report (IOM, 2000) Findings Regarding Associations between Indoor Exposures and Asthma

Development of Asthma		Exacerbation of Asthma	
Biological Agents	*Chemical Agents*	*Biological Agents*	*Chemical Agents*
Sufficient Evidence of a Causal Relationship			
Dust mite	(no agents met this definition)	Cat Cockroach Dust mite	ETS (in preschool-aged children)
Sufficient Evidence of an Association			
(no agents met this definition)	ETS (in preschool-aged children)	Dog Fungi or molds Rhinovirus	Nitrogen oxides (high-level exposures)*
Limited or Suggestive Evidence of an Association			
Cockroach (in preschool-aged children) Respiratory Syncytial Virus (RSV)	(no agents met this definition)	Domestic bird Chlamydia pneumoniae Mycoplasma pneumoniae Respiratory Syncytial Virus	ETS (in older children and adults) Formaldehyde Fragrances
Inadequate or Insufficient Evidence to Determine Whether or Not an Association Exists			
Cat Dog Domestic Bird Rodent Cockroach (except for preschool-aged children) Endotoxins Fungi or molds Chlamydia pneumoniae Mycoplasma pneumoniae Chlamydia trachomatis Houseplants Pollen	Nitrogen oxides Pesticides Plasticizers VOCs Formaldehyde Fragrances ETS (in older children and adults)	Rodent Chlamydia trachomatis Endotoxins Houseplants Pollen Insects (other than cockroaches)	Pesticides Plasticizers VOCs
Limited or Suggestive Evidence of No Association			
Rhinovirus	(no agents met this definition)	(no agents met this definition)	(no agents met this definition)

*At concentrations that may occur only when gas appliances are used in poorly ventilated kitchens

Specific Indoor Exposures

An overview of the dominant indoor allergens and indoor environmental exposures is presented below:

Dust mites

The terms "house dust mite" and "dust mite" are used to describe several species of eight-legged arthropods that feed primarily on skin scales shed by humans, and are not visible to the naked eye. Mites thrive in many indoor environments, especially those in humid or temperate climates. Proliferation of these pests is determined by temperature, humidity and the presence of a food source. Therefore, mite populations reside typically in bedding (e.g., mattresses, sheets, blankets and pillows) and other soft furnishings (e.g., upholstered couches and carpeting), where human contact provides a constant source of food. Of these, bedding is considered the dominant source of mite allergen exposure for most individuals.

Exposure to dust mite allergens has been shown to contribute to both asthma development and exacerbation. The IOM report concluded that current research supports a *causal* relationship between early life exposures to dust mite allergens and asthma development, the highest level of evidence assigned in their hierarchy (IOM, 2000). Exposure to these allergens is widespread in the United States, with over 80% of homes having detectable levels in a recent survey (Arbes et al., 2003). Sensitization rates are also high, and the link between exposure and sensitization has been demonstrated in several studies.

Cockroaches

Cockroach infestation is common in many urban settings in the United States. While sensitization to cockroach allergen is less common than dust mite sensitization nationwide, it is the most common allergy among asthmatics in many urban, low-income communities, where exposures can be significant, starting in early life. The National Cooperative Inner-City Asthma Study showed that among sensitized individuals, asthma morbidity was more closely associated with exposure to cockroach allergen than any other measured allergen (Rosenstreich *et al.*, 1997).

The allergens associated with cockroaches originate from desiccated body parts, feces and other excretions. While numerous cockroach species exists, most research has been conducted on the species that are commonly found in residential environments, including the German cockroach, American cockroach, Oriental cockroach, and smoky brown and brown-banded varieties (HUD, 2006).

Mold

A complete understanding of the health effects associated with residential mold exposure is lacking at present. However, numerous studies have shown associations between mold exposure and respiratory outcomes, including asthma. Quantifying mold exposure, however, can be difficult. There are more than 1 million individual fungal species (IOM, 2000). Of these, approximately 200 species are commonly found indoors. Mold exposure generally acts through two pathways relevant for asthma. First, individuals may become sensitized to specific fungal allergens, and thus, these exposures would yield allergic reactions similar to other inhaled aeroallergens. Second, many molds produce mycotoxins (literally "fungus-derived toxins"), chemical byproducts of their metabolism, which can directly irritate the airways or enhance an underlying allergic response.

Many studies have examined the role of moisture and dampness in the home in exacerbating respiratory symptoms, including asthma. Due to the difficulties of quantifying mold exposures, it is likely that these moisture-related measures do not act directly, but rather serve as proxies for exposures to mold, endotoxins, or other biological agents.

Pets

Specific pet allergens can trigger asthma attacks in sensitized individuals. For example, cat allergen has been clearly established as an asthma trigger through inhalation, as documented in the IOM report. The role that pet exposure plays in asthma development is less clear, and risk may depend on numerous early-life factors such as the timing and level of exposure, presence of associated endotoxins, and maternal sensitization.

Environmental Tobacco Smoke

The health risks from environmental tobacco smoke (ETS) or secondhand smoke have been well established. The risk of both asthma development and exacerbation are elevated with exposure to ETS. Smoking cessation programs for household members can thus potentially improve multiple health endpoints.

Oxides of Nitrogen

The IOM report noted the importance of other indoor air exposures, including combustion sources, in the development and exacerbation of asthma. This report also concluded that intermittent high exposures to nitrogen dioxide might increase airway responses to inhaled allergens and nonspecific irritants. These exposures would result from the use of gas appliances in poorly ventilated kitchens, as well as from the use of a gas stove for supplemental heating.

INTERVENTIONS

Asthma exacerbation can be controlled through clinical and environmental interventions. Clinical assessments are of primary importance, since many asthmatics, especially those living in poverty, may not have received adequate treatment or may not adhere to their medication regimens. The predominant strategy for the environmental control of asthma has focused on the elimination or avoidance of triggers. Exposure to airborne triggers, which can act through allergenic or irritant pathways can be reduced through source elimination, behavior modification, and air cleaning.

Source elimination can involve the elimination of pest infestation, removal of a pet or reduction in dust reservoirs. Since dust reservoirs can represent years of aeroallergen releases into a home, it is important to address these historical dust loadings in addition to current sources from active pest populations. Some approaches may be effective in reducing exposure to a wide array of household allergens, such as cleaning with a vacuum equipped with a high efficiency particulate air (HEPA) filter or increasing ventilation rates. Thus, improvements in ventilation can provide significant benefits as this measure can reduce several exposures concurrently. However, the design of effective control also requires an understanding of the source organism and the physical properties of the airborne particles that carry these allergens.

Dust mites

Exposure to dust mite allergen can be controlled through several methods. The most common recommendations include the replacement or removal of furnishings that serve as dust reservoirs (e.g., bedding and carpet), encasement of bedding (e.g., mattress and pillow covers), frequent washing of bedding in hot water (greater than 130°F) and cleaning of other reservoirs (e.g., steam cleaning of carpeting). Mattress covers work by preventing movement of dust mites and their allergenic debris from within the mattress, where they live and breed, to the surface where human contact provides their primary food source.

While these approaches have proven effective in reducing allergen loading, the associated effect on asthma morbidity has been debated. In a well-publicized study, (Woodcock *et al.*, 2003) showed that

the use of allergen-impermeable bed covers did not result in improvements in several morbidity-related outcomes in a group of asthmatic adults. The study suggested that providing allergen-proof covers in a family-practice setting is unlikely to lead to clinical improvements in the absence of more comprehensive allergen avoidance (Platts-Mills, 2003). However, other published studies have shown improvements in measures of asthma morbidity, and the distribution of mattress and pillow covers continues to be a common component of home-based asthma programs.

Another challenge is that, since mites are not visible to the naked eye, the effectiveness of control methods cannot be easily monitored. Commercially available methods allow the quantification of these allergens in settled dust, but these sampling and analysis methods are not always convenient or affordable.

Cockroaches

Traditional techniques for residential cockroach control have focused on the application of pesticides to access points or areas with high activity levels, such as kitchens or bathrooms. Given the possibility for excessive exposure to potentially harmful pesticides and the limited long-term effectiveness of pesticide-only methods, more integrated approaches have been developed. Originally developed for agricultural settings, Integrated Pest Management (IPM) is an approach that attempts to modify cockroach habitats with limited application of chemical-based pesticides. Habitat modification is accomplished by limiting food and water sources, as well as eliminating opportunities for shelter and access.

Where pesticides are necessary, formulations that limit resident exposure are used, such as gels and baits (in contrast to foggers and sprays that can release significant quantities of active ingredients into the air). As discussed above, allergen residues can remain after cockroach populations have been eliminated. These residues can contribute to airborne levels capable of triggering attacks.

Pets

Removal of a pet from a home is known to reduce the burden of pet-specific allergens. While this approach is an obvious remedy, it may only be practical in extreme cases. If pets are removed from the home, however, significant quantities of allergens will remain. Since many pet allergens (e.g., cat) are generally associated with small particles, they remain airborne for long periods of time and can be easily transported between reservoirs. It is common for these allergens to be present in settings where no pet resides. Cat allergen, for example, is common in schools, where children can carry allergen residues on their clothing and transfer this material to the classroom environment and, ultimately, to their classmates.

Other approaches that may reduce the pet allergen burden include: removal of allergen reservoirs (including carpets and upholstered furniture), regular cleaning with a HEPA vacuum, HEPA air filtration, frequent pet washing and the use of topical sprays on pets (HUD, 2006).

Mold

While low levels of airborne fungi exist normally in ambient air, and thus, in most homes, patches of visible mold on household surfaces can release spores, mycotoxins and fungal debris capable of triggering asthma attacks. Since the principal factor contributing to mold growth is the availability of moisture or water, any remediation plan must first identify and address the source of this water. Common sources include: condensation on exterior walls, humid enclosed spaces, plumbing leaks, flooding, humidification systems and sprinkler systems.

Guidelines for the remediation of visible mold have been developed by various organizations and public agencies (NYC DOHMH, 2002). These guidelines typically classify mold problems by the size

of the affected surface area. For small areas of surface contamination (e.g., a few square feet or less), surface washing with a dilute bleach solution may be sufficient. Widespread contamination requires professional remediation using appropriate containment protocols. All mold remediation should proceed with the use of personal protective equipment.

Costs Associated with Interventions

Environmental interventions that involve environmental remediation, durable goods or any contracting for services can incur significant costs. Some rough estimates of these costs are presented in Table 4-3.

Table 4-3: *Approximate* Costs for Various Home Interventions

Intervention	Cost	Cost Variability
Mattress and pillow covers	< $100	Low
Air cleaner (HEPA)	$100-200	Low
HEPA vacuum	$100-200	Low
Smoking cessation	< $1000	Med
Food storage containers	< $50	Low
Mattress replacement	$300+	Low
Minor repairs	$200-$500	High
Mold/moisture remediation	$200+	High
Targeted repairs – pest access	$200+	High
Combustion appliances – removal/replacement	$500+	Med
Home cleaning	$200-$1000+	High
Integrated Pest Management contractor	$200-$1000+	High

Research Studies

Several published studies have demonstrated the ability of home-based interventions, employing some of the approaches described above to reduce asthma morbidity. A list of representative studies is presented in Table 4-4, with key studies described below:

The **Inner City Asthma Study** focused on providing education and supplies to achieve reductions in indoor allergens and environmental tobacco smoke in a multi-center cohort in high-poverty areas. Symptom reductions were demonstrated during the intervention year and the year afterward (Morgan et al., 2004).

The **Seattle-King County Healthy Homes Project** similarly showed improvements in Quality of Life scores and reduction in urgent health services use over the year following an intervention that included mattress covers, low-emission vacuums, smoking cessation referral, pest control and cleaning supplies (Krieger *et al.*, 2005).

In the **Healthy Public Housing Initiative**, educational and environmental interventions resulted in improvements in Quality of Life measures for asthmatic children and their caregivers, as well as reductions in symptoms and activity limitations. Subjects for this study were recruited from three public housing developments in the Boston area. Interventions included new mattresses, commercial cleaning to remove allergen residues, low-toxicity pest control applications (e.g., gels, baits and traps), and family pest control. The percentage of children experiencing daily wheezing symptoms was reduced from 15%

to 2%. The percentage of children experiencing no wheezing symptoms (over a one-week reporting period) was increased from 20% to 47% (Levy *et al.*, 2006).

(The studies described above also included clinical evaluations to insure an appropriate level of medical care for each subject, but these details are not discussed here.)

Cost-effectiveness

Despite this growing body of evidence of the efficacy of in-home environmental interventions, these services are difficult to sustain and have not been widely adopted. To further evaluate these interventions, several efforts have been made to assess their cost-effectiveness. For example, (Brugge et al., 2004) reviewed several published studies that presented cost-effectiveness data. They concluded that reduction in direct healthcare costs were most apparent among severe asthmatics.

The National Cooperative Inner-City Asthma Study (NCICAS) analyzed the cost-effectiveness of their intervention, which included a social worker based education program and environmental control measures. When compared with "usual" care, health outcomes were improved at an additional cost of $9.20 per symptom-free day. This cost is comparable to that associated with widely accepted pharmacologic treatments for asthma (specifically, inhaled corticosteroids) (Sullivan et al., 2002).

The Inner-City Asthma study (ICAS) similarly analyzed the cost-effectiveness of their environmental intervention (Kattan et al., 2005). This intervention included targeted reduction of environmental irritants and allergens through the use of: allergen-impermeable mattresses, HEPA vacuums and either HEPA air cleaners or vent filters. The costs of the interventions were estimated at $1469 per family. In this case, health outcomes were improved at an additional cost of $27.57 per symptom-free day. In addition, the authors made several observations not reflected in this estimate. First, when compared to the NCICAS, the ICAS achieved 40% additional symptom-free days. Second, they observed significant improvements in the number of school days lost due to asthma morbidity, although these improvements are not reflected in the economic analyses.

The lack of additional data on this subject is a barrier to widespread implementation, especially among insurers. In order to justify investments in durable good and services for trigger control, beyond those of minimal cost (e.g., mattress covers), insurers need to understand the cost-effectiveness of such efforts.

Table 4-4: Asthma studies that utilized multiple interventions

Study	Design*	Cohort	Interventions										Results
			Asthma Education	Environmental Education	Physician Education	Pest Control	Mattress Covers	Smoking Cessation	Cleaning Supplies	Professional Cleaning	HEPA Air Cleaners	HEPA Vacuum Cleaners	Other	
Seattle-King County Healthy Homes Project	RCT	274 low-income households with asthmatic children aged 4-12. "High-intensity" intervention compared with "low-intensity"	•	•		•	•		•			•		Significant improvements in caregiver Quality of Life scores and reductions in both urgent care services and days with activity limitations (all $p<0.05$). Trends toward decrease in asthma symptom days ($p=0.138$) and school days missed ($p=0.105$) (Krieger et al., 2005).
Healthy Public Housing Initiative	IT	50 households with asthmatic children aged 4-17 living in Boston public housing	•	•		•			•	•				Symptom reduction in percent of subjects experiencing daily wheezing symptoms (15% pre vs. 2% post). Significant increase in percent of subjects experiencing no wheezing symptoms (20% to 47%) (one-week reporting periods) (Levy et al., 2006).
Inner-City Asthma Study	RCT	937 asthmatic children aged 5-11 living in low-income neighborhoods in 7 US cities		•		•	•				•	•		Intervention group had fewer symptom days (2 week reporting period) in both intervention year (3.39 vs. 4.20 days, $p<0.001$) and following year (2.62 vs. 3.21, $p<0.001$). Reductions in dust mite and cockroach allergens also observed (Morgan et al., 2004).

* Abbreviations RCT = randomized control trial, IT = intervention trial

Table 4-4: Asthma studies that utilized multiple interventions (continued)

Study	Design*	Cohort	Interventions										Results
			Asthma Education	Environmental Education	Physician Education	Pest Control	Mattress Covers	Smoking Cessation	Cleaning Supplies	Professional Cleaning	HEPA Air Cleaners	HEPA Vacuum Cleaners	Other	
Johns Hopkins	RCT	100 asthmatic children aged 6-12 living in Baltimore	•	•					•			•		Daytime symptoms increased in the control group and decreased in the intervention group (p=0.04). Additional measures (spirometry, nighttime symptoms, and emergency department use) were not significantly changed (Eggleston *et al.*, 2005).
Urban Mold and Moisture Program Asthma Study (Cleveland)	RCT	62 symptomatic asthmatic children aged 2-17 living in a home with indoor mold		•									Mold mediation, including household repairs and re-modeling	Significant decrease in symptom days in intervention group (p=0.003). No change in control group. Lower exacerbation rate in intervention group (p=0.003) (Kercsmar et al., 2006).
Childhood Asthma Prevention Study (CAPS) (Denver)	RCT	181 infants aged 9-24 months with 3 or more physician-documented wheezing episodes	•	•					•			•		Significant reductions in cockroach allergens and urinary cotinine. Caregivers showed knowledge improvements. Symptoms and healthcare utilization did not show improvements with intervention (Klinnert *et al.*, 2005).

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RHODE ISLAND LEAD CENTERS – CAPACITY ASSESSMENT

Overview of Purpose

As stated earlier, a significant public health and housing resource network has been built in Rhode Island to treat and prevent lead poisoning among children. An important element of this model includes the Certified Lead Centers, which provide non-medical case management statewide for children with blood lead levels (BLLs) of 15 micrograms per deciliter (µg/dL) or greater. The Lead Centers collectively possess extensive experience reaching out to and assisting families of Rhode Island children with elevated blood lead levels (EBLLs). With the number of cases of EBLLs continuing to decline statewide, the Rhode Island Department of Health (HEALTH) anticipates that the Lead Centers will have excess capacity and it has been suggested that the "Lead Center" model may be expanded to serve families of children with asthma. The purpose of this review is to assess the operational capabilities of Lead Centers to undertake non-medical asthma case management services.

Background

LEAD CENTERS

There are currently four Certified Lead Centers that provide non-medical case management statewide for children with blood lead levels (BLLs) of 15 micrograms per deciliter (µg/dL) or greater (Table 5-1). All four Lead Centers have signed a Memorandum of Understanding (MOU) with the Rhode Island Childhood Lead Poisoning Prevention Program (RI CLPPP) for purposes of receiving referrals, providing case management services, and working jointly on quality improvement efforts. The Rhode Island Department of Human Services (DHS) issues certification standards for the Lead Centers and provides Medicaid funding for services to Medicaid (RIte Care)-eligible children. There is currently no source of funding available for non-Medicaid children; however, the Lead Centers have been providing services to all children regardless of funding.

The first Rhode Island Lead Center ("HELP Lead Safe Center") was founded in October 1998 to provide a full range of non-medical services to lead poisoned children and their families. This Lead Center was later taken over by St. Joseph's Hospital in Providence. In 2002, the Department of Human Services (DHS) re-issued the certification standards to ensure that services were accessible statewide and approved three new Lead Centers to begin operations as of January 1, 2003: Blackstone Valley Community Action Program (CAP), Family Service of Rhode Island, and West Bay CAP. In September of 2005, one Lead Center (Family Service) withdrew from providing these services to families of lead poisoned children due to the financial burden of providing case management services to a large non-Medicaid population. In 2006, East Bay CAP was certified as a new (fourth) Lead Center to offer lead case management services in Rhode Island.

Responsibilities of Lead Centers

The Lead Center's responsibility to provide follow-up services to a lead poisoned child begins at the time the "Inspection Referral Form" is faxed to the Lead Center from HEALTH. Lead Centers are required to provide complete case management services for all children with BLLs 15 μg/dL or greater, as detailed in DHS Lead Center Certification Specifications, which include, but are not limited to:

- Initial needs assessment
- Family care plan
- Medical care coordination
- Non-medical case management
- Assistance with housing inspections (walk through with inspector, visual assessments)
- Education and training
- Housing relocation assistance
- Intensive abatement, as necessary, including intensive environmental cleaning services, spot repair (duct tape and TSP) and window replacement (see below).

Of the 141 children referred to the Lead Centers in 2005, 111 (85%) accepted services and the remaining 30 (15%) did not receive services either because they refused or could not be located after several attempts. Cases remained open for approximately 8.5 months, on average, and 35 cases were closed after receiving services in 2005.

In 1999, RI CLPPP expanded services to include referrals for children with lead levels of 15-19 μg/dL. Children with first time blood lead levels of 15-19 μg/dL are eligible to receive home visits and education from a Lead Center; however, an environmental inspection is not offered to this group. In 2003, 270 families fell in this category and were referred to Lead Centers. The number of referrals for first time blood lead levels of 15-19 μg/dL in 2004 and 2005, respectively, were 199 and 129. As of January 2006, these cases are only referred if the lead level is from a venous test. This change occurred after recognizing that most parents refused services based on a capillary result of 15-19μg/dL and waited for venous confirmation before accepting lead center services.

Other Case Management Services

FAMILY OUTREACH PROGRAM

Since March 1999, families of children with confirmed BLLs ranging from 10-14 μg/dL have been sent a letter from RI CLPPP encouraging them to contact the HEALTH Family Outreach Program to receive a home visit (not a comprehensive lead inspection) to learn more about the dangers of lead in their homes. In 2005, 680 children had first-time elevated blood lead levels between 10-14 μg/dL and the Family Outreach Program provided 54 free, home-based lead education visits. Of the 680 children, 247 families residing in the City of Providence received a letter from RI CLPPP offering a free home inspection and 16 families requested an inspection.

INSPECTIONS AND ENFORCEMENT

Comprehensive environmental lead inspections (CELIs) are provided as part of environmental case management for children who meet the Rhode Island definition of significantly lead poisoned (synonymous with EIBLL-Environmental Intervention Blood Lead Level) and for day care facilities licensed by the Department of Children, Youth and Families (DCYF). Environmental Intervention Blood Lead Levels (EIBLLs), or significantly lead poisoned children, are defined as having two venous

blood tests with lead levels between 15-19 µg/dL or one venous blood lead test >20 µg/dL and are referred to Lead Centers for case management and environmental inspection. In 1998, inspection services for significantly lead-poisoned children were privatized and are currently conducted by a pool of private, certified and licensed environmental lead inspectors who send their inspection reports to HEALTH and are reimbursed for their services through Medicaid as appropriate. The privatization of inspection services has led to a decreased time from identification, referral, and inspection to approximately three to four weeks. The Lead Center case managers are required to assist the inspector in reaching the family as well as to assist in helping the family to understand the inspection results. The RI CLPPP conduct all resultant follow-up and enforcement activities, including: on-site consultations, documentation, compliance, involvement in legal actions, clearances/sample collection and issuance of lead safe certification. In 2005, 158 environmental inspections were offered with inspections completed in 101 homes and lead hazards identified in 98 of these homes. Reasons for inspections not being performed included: child moved (N=19); no response to letters and calls (12); inspection refused (20); and inspection pending (6).

MEDICAID FUNDING FOR WINDOWS REPLACEMENT AND SPOT REPAIR

In addition to providing Medicaid funding for comprehensive non-medical case management through Lead Centers, Rhode Island DHS became the first State Medicaid agency to obtain approval to utilize Medicaid funds for the replacement of windows in the homes of Medicaid-eligible lead poisoned children. Window replacement can be made at a cost of $214.00 per window to the home/building owner. Given the many conditions that must be met and the complex logistics that are required to complete the window replacement process with Medicaid funding, Lead Centers are not always able to work out the logistical barriers and property owners often refuse this service.

Funding Issues

The Lead Centers are funded and certified by Rhode Island DHS (Medicaid) as providers of medical care coordination, non-medical case management, lead education and training, and housing relocation assistance to lead poisoned children as established in the "Lead Center Specifications" issued by DHS. Each Medicaid-eligible case is reimbursed on a fee-for-service basis according to the following schedule: $257.00-initial contact fee; after 7 days, bill on a monthly basis for maintenance ($2.58/day limited to 4 months) or intensive follow-up ($6.35/day limited to 6 months); and a $250.00-close case fee. Non-Medicaid families receive services without reimbursement to the Lead Center. Cases remain open on average for approximately 3-12 months (8.5 months on average) which depends on several factors, including, but not limited to: the ability to reach the family, repeat/follow-up BLLs, and the number of times the family relocates.

In 2006, there were 208 cases referred to the four active Lead Centers (Source: RI Dept of Health, CLPPP, LESS database, K. Truong personal communication). Approximately 56% of these cases were Rite Care patients and 44% were Non-Rite Care patients. At the beginning of 2007, between 78% and 100% of cases that were referred in 2006 at each of the four Lead Centers remained open (Note: East Bay Lead Center received its first referral in September 2006).

This highlights an important challenge of the Lead Center model. In September 2005, the Family Service Lead Center withdrew its participation and terminated services because of the operating loses experienced due to the small number of cases referred to their geographic area and the burden of Non-Rite Care-eligible families who required services without reimbursement for such cases. In spite of the lack of funding, the Lead Centers are still providing case management services to non-Medicaid eligible families and are exploring other avenues of funding.

Quality Assurance Activities

In January 2003, a comprehensive evaluation of case management services for children with elevated blood lead levels was completed by HEALTH. The following recommendations were made:

- The case capture rate needs to be improved.
- Case closure criteria should be more explicit, uniform, and incorporate quantitative measurements.
- More timely follow-up blood testing, and increased coordination with the child's PCP is needed.
- Educational efforts should include more information on the maintenance of a lead safe environment and long-term vigilance for lead hazards.
- Strategies to increase compliance with the environmental inspection should be developed
- Improved tracking of referrals to other agencies for assistance should be developed.
- Additional research is needed to evaluate the declines in blood lead level resulting from case management.

Five specific areas were addressed and included: medical coordination, developmental assessment, education, nutrition and housing referrals. As a result of this evaluation, the development of the following outcome measures were discussed:

- Percent change in score on a parental pre/post test to assess knowledge of lead
- Rate of change of blood lead levels before and after case management
- Rate of screening among siblings of children with elevated blood lead levels
- Percent of children in WIC before and after case management
- Percent of children with completed developmental assessment using the "Ages and Stages" Questionnaires (ASQ)
- Percent of children enrolled in Early Intervention (EI) before and after case management
- Percent of children that are referred to other services
- Percent of families who receive spot repair/window replacement
- Percent of families who accept an inspection when offered
- Number of successful lead hazard reduction applications

With the addition of three new Lead Centers in January 2003, RI CLPPP identified the need to bring managers of the centers together on a regular basis to share knowledge and offer technical assistance to the newer lead centers.

RI CLPPP and DHS performed site visits at the four Lead Centers in 2003, and again in the fall of 2005 at the three remaining active Lead Centers. Findings and recommendations will be shared with each lead center and an action plan is being developed by RI CLPPP to address issues and suggestions for improvements that were identified during the site visits.

RI CLPPP is working with DHS to provide one-on-one training for case managers and to coordinate additional refresher trainings on topics such as the "Ages & Stages" developmental screening tool. In addition to these trainings, RI CLPPP developed and distributed a Case Management Protocol (June 2005) intended to be used as an operational guide to handle referrals that contains additional information, such as form letters and reports, to supplement the information in the DHS Lead Center Certification Standards.

For cases opened since January 2004, RI CLPPP began collecting additional data from each lead center upon closing a case, which will be used for evaluation and programmatic purposes.

Elevated Lead Levels in Rhode Island

The prevalence of lead poisoning in children under the age of six has shown a steady decline from 17.7% in 1996 to 3% in 2005. Although the prevalence of lead poisoning in Rhode Island has been steadily declining, a total of 981 children were lead poisoned (BLL $\geq$ 10 µg/dL) in 2005. The proportion of new cases among children screened for lead poisoning has also declined dramatically from 12.3% in 1996 to 2% in 2005 which represents 621 children with elevated blood lead levels reported for the first time in 2005. The incidence of lead poisoning by birth cohort is defined as the proportion of children born in a given year who became lead poisoned before the age of six. The risk of a child becoming lead poisoned in Rhode Island has decreased over time with approximately one in four children (29.6%) born in 1992 being lead poisoned before the age of six, compared to one in fourteen children (6.9%) of those born in 1999.

There are currently six cities in Rhode Island: Central Falls, Newport, Providence, Pawtucket, West Warwick, and Woonsocket that are designated as "core cities," where the child poverty level is greater than 15% (according to the 2000 Census). In 2005, the incidence of lead poisoning in the core cities was 3.4%, compared to less than 1% in the remaining cities and towns. Figure 5-1 shows the geographic distribution of the 621 newly identified BLL $\geq$ 10 µg/dL in Rhode Island (2005) with core cities shaded. Since the blood lead surveillance data relies on laboratory collection and reporting of information, data on race/ethnicity is available on only about 50% of samples and thus is not reported by RI CLPPP.

Effectiveness of Environmental Intervention and Case Management for Lead Poisoning

Case management of children identified with EBLLs involves coordinating, providing, and overseeing the services required to reduce their BLLs below the level of concern (10 µg/dL)(CDC, 2002). Nationwide, there are currently widely varying definitions of what criteria should be utilized for closing a case and terminating case management services (CDC, 2002). It is also recognized that it often takes an extended period of time to complete a case management plan. Controlling residential lead hazards is critical for case management of lead poisoned children (McLaine et al. 2006). A randomized, community-based trial was designed to measure the effectiveness of intensive case management in comparison standard case management services (Brown, et al. 2006). BLLs declined overall by 47% and after one year nearly half of the children had BLLS <10 µg/dL, but the difference by treatment group (intensive vs. standard care) was not statistically significant. In another study, evaluating the effectiveness of housing policies in reducing children's lead exposure, the risk of identifying one or more children with BLLs of 10 µg/dL or greater was four times higher in addresses with limited enforcement policies in place (Brown et al. 2001). A recent study analyzed childhood blood lead surveillance data from 1994-1995 and case management protocols from six states (including Rhode Island) that reported the results of all blood lead tests (Whitehead & Leiker, 2007). Blood lead levels declined by 1.96 µg/dL among children covered by a case management protocol that included a home visit and by 0.92 µg/dL among those covered by a protocol that included a lead source investigation. These results indicate that case management protocols that include a home visit are more effective in reducing children's' BLLs regardless of initial BLL and age.

Overlap of Lead and Asthma Cases

Lead poisoning and asthma are pediatric health problems that have been linked to the home environment and both occur frequently in low socioeconomic status, urban areas (Hartert and Peebles 2000; Lanphear et al. 1998). There is some biological evidence to suggest that cases of lead poisoning and asthma could be related. Published studies suggest that lead exposure may lead to alterations in

immune system mechanisms that are also related to asthma risk (Lutz et al. 1999; Sun et al. 2003). Lead exposure has been associated with excessive production of immunoglobulin E (Snyder et al. 2000; Annesi-Maesano et al. 2003) which is observed in individuals with asthma. One study found that the effect of lead on IgE was stronger in females than males (Sun et al. 2003) which may provide additional insights to sociodemographic disparities.

Two published studies have examined the potential overlap between cases of lead poisoning and asthma and neither found an association. One study set out to examine racial differences in blood lead levels on the risk of developing asthma. Participants were 4,634 managed care enrollees with BLL measured at 1-3 years of age. Among Caucasians, the association of BLL $\geq$ 5 μg/dL with asthma was slightly elevated, though not statistically significant (adj HR=1.4, 95% C.I. 0.7-2.9, p=0.4). When comparing African Americans to Caucasians with BLL < 5 μg/dL, they were at increased risk for asthma regardless of BLL. Therefore, the authors concluded that the effect of BLL on increased asthma risk was not observed (Joseph et al. 2005). An earlier but smaller study examined 101 patients at an inner-city clinic in Chicago with BLL of 25 μg/dL or higher who were randomly-selected and matched on age, sex, and primary language to 101 randomly-selected patients with a first BLL of less than 5 μg/dL. Both groups had a similar number of subjects with a diagnosis of asthma: 6% of those with BLL $\geq$ 25 and 11% of those with BLL < 5 μg/dL (NS) or history of asthma or asthma symptoms: 26% of those with BLL $\geq$ 25 and 34% of those with BLL < 5 μg/dL (NS). Overall, subjects in the high blood lead group had delayed immunizations and older age at first clinic visit than the subjects in the low blood lead group. In this study, there was no increased likelihood of asthma diagnosis or symptoms among young children with lead poisoning (Myers, et al. 2002).

HEALTH conducted a pilot study with BCBSRI examining the overlap between asthma cases and children with elevated blood lead levels – there were very few patients in common, although there were some limitations in the study design (Personal Communication, Ruth Lindberg HEALTH). Overall, there is little evidence to support the notion that children with EBLLs are the same children as those who have or later develop asthma. However, the studies to-date have not been large enough or conducted long enough to rule out the possibility entirely. A large, prospective study is needed to examine the relationship between EBLL at 1-2 years of age and later onset of asthma. Existing databases also can be used to examine this issue. For example, RIte Care data can be used to link lead poisoning in early life with asthma claims several years later (for children who can be tracked during these periods). Also, associations between claims and addresses can examine the role that specific residences may play in these outcomes.

Important Differences between Lead and Asthma

These following contrasts highlight important factors for the design of a case management model for asthma and must be considered when transitioning from a "lead" to an "asthma" model of case management. Since lead is mainly an environmental condition, non-medical case management is at the forefront of the treatment plan. Asthma management follows much more of a traditional medical model.

Lead is a toxin that is easily identifiable and, in children, lead poisoning is most often related to lead paint and dust in older homes. There are legal issues associated with the enforcement of federal laws and State and local housing codes. Elevated BLLs are generally non-symptomatic or accompanied by generalized symptoms such as stomach upset and fatigue or, in chronically-exposed children, behavioral or developmental symptoms may arise. There is no treatment except for removal from the source or chelation therapy, which is recommended only for levels $\geq$ 45 μg/dL (CDC, 1990).

Asthma triggers or the root cause of disease may not be easily identifiable and may or may not be housing-related. Asthma is a symptomatic disease of varying severity that is responsible for a

substantial amount of suffering, and may even result in death, when poorly managed. There are multiple treatment modalities and several classes of medication associated with asthma treatment regimens. In addition, asthma is a chronic condition that may be with the patient for life.

Lead Center Thoughts on Expanding Service into Asthma

The center at St. Joseph's Hospital has expressed interest into expanding services to include asthma case management and has explored the potential with Hasbro/Americorps to develop this capacity. The other Lead Centers are similarly enthusiastic about the idea of expanding their services and several staff members are already familiar with the "Healthy Homes" concept. To that end, the Lead Centers offered the following list of strengths and challenges that would be faced in such an endeavor.

STRENGTHS OF THE LEAD CENTERS:

1) Social work/community nursing background/case management perspective provides a holistic assessment of family needs and care plan – they are good at working with families and making referrals.
2) Localized Centers are familiar with local needs – not a centralized system for the entire state.
3) Experience finding and tracking clients in transient and disenfranchised populations.

CHALLENGES FACED BY THE LEAD CENTERS:

1) The major obstacle facing the Lead Centers is funding; in particular the lack of reimbursement for Non-Medicaid clients.
2) Finding and tracking clients is a challenge due to the transient nature of the population served.
3) Housing codes vary significantly by city.

In our discussions during the fall of 2006, the Lead Centers expressed specific suggestions and considerations for the implementation of any new program (i.e., asthma):

Suggestions:

- Additional staffing requirements would need to be based on the "program standards" defined by new program.
- Significant education and training would be necessary for the start-up of any new program and additional training of staff upon turnover or hiring new employees. Cited difficulties in starting up new Lead Centers include communication issues with DHS and DOH regarding guidance for start-up and standardization of training materials.
- There is a need for standardization of protocols, forms, and databases.
- There is a significant need to educate landlords.
- It was suggested by the Lead Centers that they meet on a more frequent basis (e.g. monthly) to share experiences and challenges. This could include DOH and DHS on a less frequent basis (e.g. quarterly).

Considerations for Using Lead Center Model for Asthma Case Management

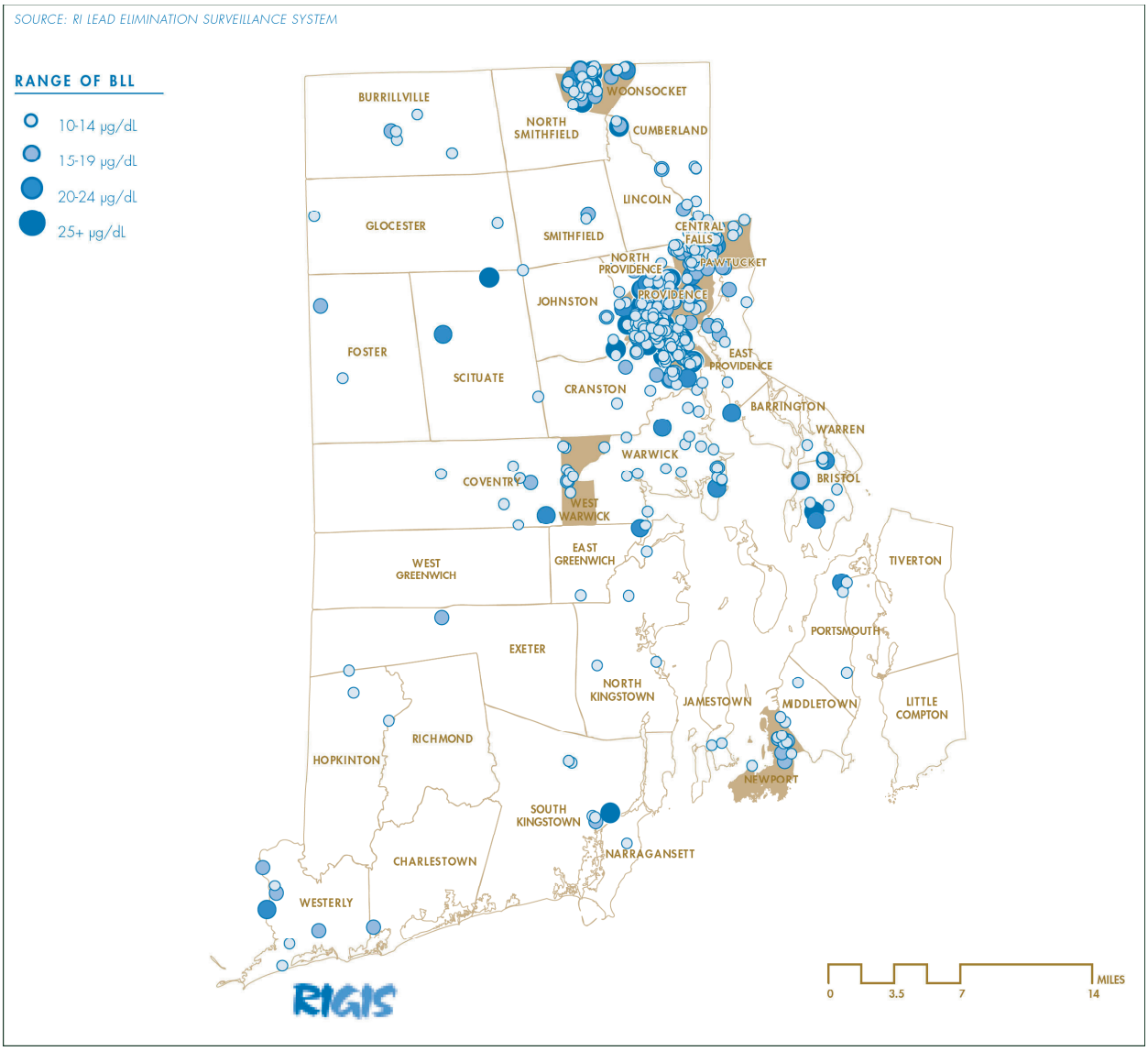
- Need to consider that a fee-for-service model may not work for asthma, since it is a chronic condition – at what point do you decide to close a case? Need case definitions and closure rules.
- Current reimbursement structure is not efficient since there is incentive to drag out case management to increase the amount of reimbursement per case (given they are paid by the day, up to a cap).
- Medically-trained staff seems to be more necessary for asthma management than for lead.
- Need to include the "multiple poisonings per address" idea into asthma model – perhaps multiple risk factors (e.g., infestation, mold)

Need to capitalize on strengths of KIDSNET system for outreach to families and providers – receives information on BLLs and environmental inspection, but no information on asthma and currently no plans to add it.

Table 5-1. Certified Lead Centers, Rhode Island (2007)

Certified Lead Center	Inception Date	Staffing	Service Area	Population Served	Estimated Case Load
Blackstone Valley Community Action Program Lead Center (Pawtucket)	January 2003	Jan Winter, Housing Programs Supervisor Cases Managers (2) each work 75% FTE on lead	Blackstone Valley (Pawtucket, Woonsocket, Central Falls)	Mostly Medicaid (75%), renters (95%), Spanish-speaking (50%). Mainly triple-decker houses. Quite a few high (30-50 µg/dL) lead levels	40-50 cases at one time
East Bay Community Action Program Lead Center (Newport)	September 2006	Karen Izzo, Housing Programs Supervisor Luana Cherenzia, Case Manager (100% FTE)	East Bay Area (Newport, Portsmouth, Jamestown, Middletown)	N/A – new center	N/A – new center
St. Joseph Hospital Lead Safe Center (East Providence)	October 1998	June Tourangeau, Case Management Director (100% FTE) Marie Padilla, Case Manager (100% FTE)	Providence, East Providence, and also Statewide	Most cases are in inner-city Providence. Many Spanish (and some Cambodian) speakers.	60-70 cases at one time, each lasting approx. 3-12 months
Westbay Community Action Program Lead Center (Warwick)	January 2003	Paula Dunne, Case Management Director Cindy Graves, Case Manager (50% FTE on lead)	Kent County Washington County (Cranston, Westerly, Warwick)	Mostly English-speaking, privately-owned single-family homes from Kent County (50%) with moderate lead levels. Other 50% Medicaid clients in Warwick.	17-18 cases at one time, each lasting approx. 6 months

Figure 5-1. Distribution of Newly-Identified BLLs ≥ 10 µg/dL, Rhode Island (2005)



From: Childhood Lead Poisoning in Rhode Island: The Numbers 2006 Edition. Rhode Island Department of Health Childhood Lead Poisoning Prevention Program. Map of Lead Poisoning Incidence 2005, Page 19.

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PILOT PROJECT DESIGN

In order to determine the feasibility of implementing a statewide model for asthma interventions, a pilot program should be used to provide data that answer critical questions on design and implementation. This pilot program should be grounded in scientific methods that will allow the State to: determine the efficacy of environmental interventions to reduce asthma morbidity, as compared with traditional clinical interventions; quantify associated costs and benefits, including the incremental benefits of more intensive efforts; and account for other potential influences on changes in health outcomes. The pilot should be designed to provide sufficient data to make policy decisions regarding Medicaid/health plan coverage for asthma environmental interventions.

Design Considerations

The implementation of a pilot program to test a statewide model for asthma interventions will require the participation of numerous stakeholders. Rhode Island has many resources, public and private, that have worked together on improving the health of asthmatics. An example of this collaboration is the Rhode Island Asthma Control Coalition, which includes representatives from the Rhode Island Department of Health, hospitals, community health centers, health plans, non-governmental organizations and community action programs. The specific design of the pilot program would be determined by external considerations, such as funding availability, staffing, in-kind contributions and other commitments from stakeholders. The information presented here is intended to provide the framework for the design process, to be constrained by available resources.

It is important to recognize that the current scope of the asthma problem in Rhode Island is larger than that associated with lead poisoning, based on the population affected. For example, in 2006, there were 208 cases referred to the four active Lead Centers (Source: Rhode Island Dept. of Health, RI CLPPP, LESS database, K. Truong personal communication). Approximately 56% of these cases were RIte Care patients and 44% were Non-RIte Care patients. In contrast, according to a 2007 HEALTH report:

- An estimated 1 in 10 adults (9.6 percent) aged 18 and older currently have an asthma diagnosis (‘current asthma)
- An estimated 1 in 10 children (10.1 percent) under the age of 18 currently have an asthma diagnosis (current asthma)

These prevalence rates were echoed by a 2006 report (ARC, 2006) showing that the lifetime asthma rate for adults in Rhode Island was 14.6%.

Therefore, the scale of the problem limits the ability of the Lead Centers to fully absorb case management duties for the affected population. However, careful program design can allow the Lead Centers to serve those most in need or those for whom case management or environmental interventions will provide the greatest benefit.

Design Process

Several steps would be required to design a pilot program:

1. Identification of Target Populations
2. Determination of Case Definitions
3. Design of Tracking Systems
    - Subjects
    - Environmental Conditions
    - Outcomes
        - Healthcare Utilization
        - Patient knowledge and behavior
        - Self-reported symptoms
4. Determination of Staffing and Training Needs
5. Development of Screening Tools
6. Design of Interventions
    - Case Management framework
        - Medical Management
        - Home Visits
            - Surveys
            - Visual Inspection Protocols
            - Environmental Sampling Methods
            - Protocol for return visits
        - Coordination with and utilization of existing programs
    - Environmental interventions
        - Determination of scope
        - Susceptibility-exposure links
        - Design of decision matrix

Each of these considerations is discussed below.

Identification of Target Populations

Due to the high prevalence of asthma nationwide and in Rhode Island, it will likely be impractical to serve every person with an asthma diagnosis or asthma-related healthcare encounter. Therefore, budget and staffing considerations will define the caseload that can be supported by the program. This caseload will, in turn, determine the program's prioritization structure, based on severity or likelihood of success through environmental intervention.

Determination of Case Definitions

Most asthma programs that track or manage asthma morbidity struggle to establish case definitions that are robust and reliable. Due to the high asthma prevalence rates observed in recent years, intervention programs must focus efforts on a subset of diagnosed cases, based on disease severity or opportunities for improvements. For example, according to a 2007 HEALTH report, an estimated 10 percent of

children (grades 6 through 12) in Rhode Island have asthma. (HEALTH, 2007). Therefore, the potential "market" for asthma interventions is currently much larger than that for lead poisoning. Several options exist for focusing these efforts. Within the clinical setting, treatment guidelines typically use symptom frequency to define disease severity. NIH guidelines (NAEPP, 1997; NAEPP, 2002) have established a classification system for asthma severity that assigns a patient to one of four categories:

- Mild Intermittent
- Mild Persistent
- Moderate Persistent
- Severe Persistent

Within the individual RIte Care health plans, performance measures developed by the National Committee for Quality Assurance (NCQA) are frequently used to approximate these severity scores. These measures, part of the Health Plan Employer Data and Information Set (HEDIS), identify persistent asthmatics according to asthma healthcare utilization.

Healthcare utilization is likely to be a key factor in targeting patients for interventions. It has been estimated that 20% of asthmatic patients are responsible for 80% of the medical resources used to treat the condition. (Smith DH, et al.1997) (Anecdotal information from RIte Care health plans suggest that this trend is also true for their members) Selection of intervention targets from a pool of "high-utilizers" identified through the RIte Care plans may be the best approach to test cost-effectiveness of the program. (Note: "High-utilizers" are those individuals with numerous claims for hospitalizations, emergency department visits and medications.) A framework for identifying children with persistent asthma within the RIte Care health plans could be modeled on the current system of identifying children in need of lead screening. Since 2002, the Rhode Island Childhood Lead Poisoning Prevention Program (RI CLPPP) has worked closely with these health plans to identify children who have not been screened.

A group representing RIte Care health plans and asthma clinicians should be convened to establish a reliable case definition to be used for tracking and intervention eligibility. This is especially important for defining a control population that can be monitored concurrently with those participating in any intervention. This group can work with the Rhode Island Asthma Coalition to insure that these definitions are consistent with any ongoing outreach, tracking or intervention efforts occurring statewide.

Design of Tracking Systems

Subjects

Making initial contact with case families and maintaining this contact throughout a follow-up period of months to years can be especially challenging within low-income populations. Many households are in rental housing, move frequently, may not have phone service and may be reluctant to be contacted by agency representatives.

While both lead poisoning and asthma are elevated among children living in poverty, it is unclear whether there is significant overlap between the housing stock and household behaviors that contribute directly to these conditions. More than 80% of children in the U.S. with blood-lead levels above 20 μg/dL are eligible for Medicaid. While the association between low socioeconomic status and asthma is strong nationwide and in Rhode Island, the extent of co-morbidity within households has not been fully explored. As part of a pilot testing phase, the extent of overlap could be estimated using HEALTH data and records from the RIte Care health plans.

Environmental conditions

Creating a system for the collection, tracking and analysis of key environmental samples may be necessary. Laboratory services may be conducted by state-certified labs as necessary. The potential capacity to handle environmental testing relevant for asthma, such as testing for mold (surface, airborne and bulk samples) and allergens (airborne or vacuum dust) is not clear currently.

Outcomes

It is critical that any program include a carefully designed plan for tracking intervention subjects and 'control' populations. A control population is necessary to separate "true" intervention effects from other factors, such as changes in: true asthma incidence, healthcare utilization patterns, and population demographics. A control population would most easily be drawn from the RIte Care Health Plans, perhaps defined as those members meeting the case definition (and thus, eligibility for intervention), but who have not received the intervention, due to recruitment difficulties or case loads.

Tracking systems need to measure various measures of the program's success, which may include:

- Healthcare Utilization
  - Emergency department visits
  - Hospitalization
  - Pharmacy Claims
- Patient knowledge and behavior
  - Patient knowledge (e.g., trigger avoidance, medication use)
  - Asthma Action Plan compliance
- Self-reported symptoms

Healthcare utilization for many patients could be tracked within the RIte Care system. To evaluate the benefits of the program, it will be important to understand potential trade-offs between claims. For example, many patients with poorly controlled asthma under-utilize primary care and require excessive emergency and inpatient care. Following interventions focused on medical management, these patients typically reduce their reliance on beta-agonists, due to an appropriate increased usage of controller medications. While these regimens are more costly, they typically result in reductions in costly ED visits and inpatient services.

The use of RIte Care data to monitor utilization will allow for the direct comparison of these metrics between intervention enrollees and asthmatic members receiving standard care. However, patient knowledge and behavior and self-reported symptoms can only be tracked through surveys administered to subjects directly. Therefore, the collection of this information from a control population may not be feasible.

Program evaluation paradigms

Evaluation of the pilot program as a healthcare investment by applying two general frameworks: cost-effectiveness and cost-benefit analyses. It is worthwhile to briefly discuss these approaches here. Each methodology can provide useful information.

- *Cost-effectiveness* is used to relate program costs to its effectiveness, as measured by a condition-specific measure of morbidity for each patient. In the case of asthma, "symptom-free days" are often used to capture this measure of effectiveness. The resulting metric, "dollars per additional symptom-free day" can thus be used to compare treatments and interventions.

- *Cost-benefit* analysis puts both programs costs and health benefits into dollar terms. In the managed care setting, an investment into staffing and supplies for an asthma program would be measured against the achieved reductions in expenditures against claims.

Staffing and Training Needs

The current staffing of Rhode Island's lead centers provides many of the core skills necessary for managing an asthma intervention program. However, this staffing would need to increase in both size and scope. The development of training programs that address the pathophysiology of asthma, as well as its clinical and environmental management would be necessary. In general, the staffing needs would need to shift toward a clinical case management model, where treatment guidelines are used to provide a primary assessment of the child's health and benchmarks for follow-up. Asthma treatment guidelines established by the National Heart Lung and Blood Institute, as well as guidelines for the environmental management of pediatric asthma developed by the National Environmental Education and Training Foundation, would serve as a model. (NAEPP, 1997; NAEPP, 2002)

Effective case management requires establishing trust between the community health worker and the recipient of services and maintaining clear communication, especially among low-income populations. Therefore, insuring the ability to serve a multilingual and multicultural community through staffing and the development of education materials is critical.

Medical Management

Despite the importance of environmental risks as contributors to asthma morbidity, effective asthma case management must begin with a clinical evaluation. As mentioned above, this clinical management must follow established guideline for treatment and long-term control. Among low-income asthmatic populations, there is excessive reliance on short-term relief medications and emergency care. For many patients with persistent asthma, long-term control requires a full review of each subject's case history, which may result in a modification of prescribed medications (e.g., addition of inhaled corticosteroids). For brevity and clarity, NIH clinical treatment guidelines for asthma are not discussed in detail here; please refer to the original documentation. (NAEPP, 1997; NAEPP, 2002)

However, it is important to note that these guidelines fully recognize the importance of controlling environmental exposures for asthma patients. In addition to providing guidance on the assessment of asthma severity and providing comprehensive pharmacological therapy, these reports recommend the following two approaches to effective asthma management:

- Environmental control measures to avoid or eliminate factors that contribute to asthma severity
- Patient education that fosters a partnership among the patient, his or her family, and clinicians. *Asthma Action Plans* are a key component of education and self-management.

These recommendations align with the goals of many successful case management and intervention programs for asthma.

Enrollment period

Case management for lead poisoning typically continues for a period of time sufficient to complete an intervention and achieve reductions in measured blood lead levels. Asthma, however, is a complex disease that, while it can be effectively controlled in many cases, is a chronic condition that cannot be cured. This limits the choices for an objective endpoint. Therefore, appropriate enrollment periods for any asthma program should be sufficient to establish baseline assessments, perform interventions and

monitor outcomes over a timeframe that allows for stable estimates of key outcome data. Given the significant seasonality of asthma and the infrequency of certain outcomes, such as hospital stays and ED visits, case management should continue for a minimum of 12 months.

In general, a fee-for-service model may not work for asthma, since it is a chronic condition. The question is "At what point do you decide to close a case?" Clear case definitions and closure rules are needed to answer this question.

Home Visits

Home visits should be used as opportunities to provide targeted education, conduct inspections, obtain symptom and quality-of-life data and collect environmental samples, if necessary. These components are discussed below:

Surveys

Surveys can be used as effective means of obtaining information of patient knowledge and behavior, symptoms and important demographics. These tools will allow for tracking of subtle, yet clinically relevant improvements in morbidity that are not reflected in utilization records.

Educational materials

Self-management of asthma is critical for sustained control of the disease. To achieve this goal, targeted in-home educational efforts can effectively address both prevention and treatment. As mentioned above, Asthma Action Plans have been used successfully as a component of case management for many years. These plans guide patients through trigger identification, proper use of medications, and response measures during asthma attacks.

Visual Inspection Protocols

The current system to address residential exposures for significantly lead poisoned children in Rhode Island offers comprehensive environmental lead inspections. While inspections for asthma-related residential risks need to address numerous pathways, this institutional understanding of housing as a determinant of health is critical. Asthma inspections typically focus on those aspects of the physical home environment that are directly related to allergen or irritant exposures. These inspections also serve as opportunities for patient or household education on avoidance of asthma triggers.

Environmental Sampling Methods

Low-cost, real-time sampling methods for allergens and many respiratory irritants do not exist. However, established techniques for the collection of settled dust for allergen analyses have been employed in several large asthma studies, including the Inner City Asthma Study.

Protocol for return visits

Subsequent home visits can serve several purposes. They can serve as modules in a sequential educational program that reinforces and monitors progress. Due to the need for multiple visits to implement any environmental intervention, these educational opportunities can easily be incorporated into the program.

Intervention Designs/Decision-making

Asthma intervention programs need to be centered on a clinical case management model where, to the extent possible, it will be critical to insure proper diagnosis, treatment and medication adherence, prior to any environmental intervention.

Environmental exposure pathways for lead exposure are well established. Asthma exacerbations, however, are driven by environmental exposures that vary widely across residential settings, are often difficult to quantify, and interact strongly with the patient's underlying susceptibility. Most environmental interventions aimed at reducing asthma morbidity focus on reducing the subject's exposure to triggers. The most important triggers are indoor aeroallergens, such as those associated with dust mites and cockroaches, which can contribute to pulmonary inflammation in sensitized individuals. Therefore, reductions in these specific exposures may not be effective for all asthmatics.

Action thresholds for elevated blood lead levels have been established to guide decisions on the need for intervention. However, for asthma, understanding this relationship between exposure and susceptibility is important. Information on these factors can be assessed as follows:

> ***Sensitization data***, while very useful for a clinical decision-making, is not often available for asthmatic patients, especially those being served by Medicaid. Allergic sensitization can be determined using clinical history, skin-prick testing or RAST (radioallergosorbent test, a blood-based test which measures allergen specific IgE). While allergy testing is typically covered by health insurance, it is performed infrequently in low-income populations. Options for incorporating allergy testing into the intervention design procedure must be considered to maximize efficiency. These options may include discussing allergy testing with the patient's primary care physician, or direct referrals.
>
> ***Allergen sampling*** within the home can be used in conjunction with sensitization data to assess the likelihood that specific interventions will be successful. For example, based on existing models of asthma etiology, reductions in cockroach infestation will be most relevant for subjects sensitized to the various known cockroach allergens. While empirical evidence has suggested that exposure thresholds for allergen sensitization and exacerbation may exist, collection of the necessary environmental samples may not be practical or cost-effective. Therefore, simplified screening tools and monitoring techniques should be employed. For example, pest infestation can be monitored using simple questionnaires and the use of household traps deployed at regular intervals.

An environmental "prescription" to alleviate asthma symptoms could include anything from the distribution of a mattress cover to a whole-house mold remediation. Obviously, these interventions differ greatly in cost, effort and the expertise needed to achieve success. All of these may be considered in defining the "toolbox" or "menu" of intervention options. In establishing guidelines for what may be 'covered' in a home intervention program, there may be a preference to maximize long-term effectiveness by focusing on household products and household behavior, rather than the home's physical condition, due to the transient nature of many RIte Care members.

Coordination with and utilization of existing programs

Rhode Island has many resources, public and private, that can aid in the development of asthma intervention services.

Public entities

The Rhode Island Department of Health and the Rhode Island Asthma Control Coalition are actively pursuing coordinated strategies to address asthma. Specifically, this collaborative has worked to address the asthma problem by targeting public housing and improving the clinical asthma care within health centers .

Some of these are highlighted below.

Private entities

RITE CARE CASE MANAGEMENT PROGRAMS

The three RIte Care health plans have established case management programs for asthma. While these programs vary in selection criteria, scope of services and staffing, they all recognize the importance of integrated approaches that include: medical management, patient education and promoting strategies that reduce household environmental exposures. Incorporating the lessons learned from these programs will be essential.

HOSPITAL-BASED PROGRAMS

Successful models of asthma education have been implemented at Hasbro Hospital, including their "Draw a Breath" program and Asthma Camp for children. Opportunities for referrals into these programs, or adoption of educational materials should be explored.

OTHER AGENCIES

Lead poisoning is a health problem with a significant legal mandate, reflected in public health regulations and housing codes. Housing interventions aimed at reducing lead exposures often require communication and coordination between numerous players, including local officials responsible for housing code enforcement, private landlords, contractors and public housing authorities. Asthma-relevant risks within the residential environment, however, are not fully reflected in current regulations at the federal, state or local level. Code enforcement, therefore, may not provide incentives for private parties to make recommended improvements. For example, most housing codes require that landlords control pest infestation. An effort should be made to recognize the links to existing code, or opportunities for code revisions. Across the state, local housing codes are notoriously varied, which may require increased coordination with the relevant code officers. This interaction will be especially important, given the variety of potential asthma interventions. The program also needs to include the "multiple poisonings per address" concept into the asthma model, perhaps "multiple risk factors" (e.g., infestation, mold).

Another example of a program that benefits asthma patients is smoking cessation. Smoking cessation programs for household members may be covered by their respective health plans.

Finally, the program must also be able to use a social work model, making referrals for problems that may be interfering with families' abilities to focus on health issues.

Model programs

Most asthma intervention programs do not fully address environmental exposures. Typical models focus on medical management, patient education and, frequently, the distribution of low-cost durable goods. These goods include supplies that aid in the daily self-management of the disease (e.g., peak flow meters) or those that can be used to address allergen exposure (e.g., mattress covers). However, a wide range of effective options exists, from those with nominal costs (under $25) and minimal effort to those requiring physical remediation of the home and considerable cost (e.g., extensive mold damage).

Funding needs for a statewide asthma intervention program may be substantial. Therefore, the scope of any program would need to be established based on these resources. Possibilities include federal and state funding, RIte Care health plan covered services (new and existing), RIte Acre health plan initiatives, private foundations and private initiatives.

There are several model programs that can provide guidance on design, as well as expected costs. For example:

Inner City Asthma Study

The Inner City Asthma study employed a comprehensive environmental allergen and irritant remediation program for children aged six to eleven years living in 7 urban locations. Environmental counselors (ECs) conducted home visits over the course of a 12-month period to implement interventions to control exposure to dust mites, passive smoking, cockroaches, pets, rodents, and mold. These interventions cost approximately $1469 per family, which includes the cost of skin tests, HEPA vacuum cleaners, HEPA air cleaners, vent filters, EC salaries, travel costs and pest management services (note: not all subjects received all services). These interventions, as discussed earlier, resulted in significant reductions in symptom days, unscheduled clinic visits, and use of beta-agonist inhalers.

Boston Healthy Homes Study

The Boston Healthy Homes Study was a HUD-funded randomized control trial of environmental interventions for 250 children with asthma living in nonpublic housing in Boston. These interventions consisted of low and high intensity activities targeting reductions in allergens, indoor pollutants, mold and other triggers. These interventions were stratified across two levels: standard and enhanced interventions. Enhanced interventions included activities that required extensive inspections, contracting and follow-up. Approximate costs for the standard and enhanced interventions were $1500 and $4000, respectively.

Table 6-1: Interventions employed in the Boston Healthy Homes Study

Standard Interventions	Enhanced Interventions
Mattress & Pillow Covers	Wall to wall carpet removal
Air Conditioner	Bathroom/kitchen fan installation
HEPA Vacuum	Windows and/or door replacement
Integrated Pest Management	Plumbing and leak repair
Education/Materials	Patching of plaster
House Cleaning	Roof/flashing/gutter repair
Radiator Covers/Duct Cleaning	Repair/replace stove
Window Guards	Ventilate dryer

As stated above, environmental interventions for asthma include a wide range of options. Problems such as extensive mold damage and pest infestation would require the expertise of contractors. Hiring and managing contractors for this type of work requires its own expertise. Household repairs, elimination of pest infestation (preferably through Integrated Pest Management), mold remediation, and appliance replacement would all require established protocols for referrals and contracting.

Public Health Department Programs

In addition to the research-based efforts discusses above, several Public Health departments have implemented in-home environmental intervention programs targeting asthma. A recent review of these programs by the Asthma Regional Council (Hoppin et al., 2006) highlighted the following lessons learned:

- In-home environmental intervention programs for asthma are a good fit for health departments, but sustainability is a challenge
- Case study interviewees perceive long-term benefits to participants and program staff

- Successful in-home programs can be staffed with people who have different professional backgrounds and skill-sets
- Additional work is needed to enhance referrals and increase retention rates
- Target populations face complex multi-faceted challenges; in-home programs provide opportunities to address multiple factors that contribute to poor health
- Integrating home visits into a patient's asthma management program is important and difficult
- More resources are needed to adequately address structural problems in the homes
- Programs need to address tenants' concerns about landlord retaliation

For a full discussion of these issues, along with descriptions of model programs, please refer to the original document.

Sample size and statistical power

An important consideration in any study is sample size. Specifically, we need to answer the question "How many subjects should be enrolled in the pilot program?" if we want to objectively assess progress. Due to measurement error, random fluctuations, and un-measured sources of variability, small studies may not yield statistically significant results in situations where "true" differences exist. Therefore, studies are designed to insure adequate statistical power to detect pre-determined effect sizes, based on clinical significance or other benchmarks. Such estimates are utilized in the design of clinical trials to test the efficacy of pharmaceutical interventions. Power calculations should be based on achieving statistical significance for changes in the primary outcome variable(s). In the case of asthma, several outcomes may be relevant and useful:

- Symptom frequency
- Lung function
- Medication dispensing events
- Quality of Life measures (e.g., Juniper scales)
- Healthcare utilization (e.g., "events" and costs)

Where multiple outcomes are to be considered, the most conservative estimate of sample size is used.

Three key outcomes and their role in determining sample size are discussed below:

Healthcare utilization

In the current application, where a pilot program may be used to test the efficacy and cost-effectiveness of environmental interventions, healthcare utilization is the most relevant outcome. We do not have specific data on the distribution of healthcare utilization costs across the three RIte heath plans. Therefore, we have limited ability to determine the required sample size for this outcome. This data gap needs to be filled prior to establishing a pilot program.

To provide initial guidance, we can use an analysis of pilot data from Neighborhood Health Plan that was presented at the 2006 American Thoracic Society meeting. (McQuaid et al., 2006) This study analyzed utilization data from NHPRI's Beating Asthma program, comparing data collected pre- and post-enrollment. In this case, each subject acted as his or her own control. Participants included 57 parents of children with asthma (81%), and 13 adults with asthma. Patients demonstrated a marginally significant decrease in ED usage ($p < 0.1$), but this was associated with a significant decrease in total costs for the group from $5,162 to $3,200. The average number of hospital days reduced substantially

post treatment ($p < 0.001$), which was also associated with substantial cost reduction from $40,342 to $5,919. Outpatient visits showed only a marginal decrease ($p < 0.10$). The average number of dispenses for beta-agonist medications decreased significantly from 2.61 to 2.03 annually ($p < 0.05$). In contrast, the average number of controller medication dispenses increased from 1.81 to 2.96 per year ($p < 0.001$).

While it was not feasible in this analysis, it is preferable to use a comparable and contemporary control population as the comparison group, based on several theoretical considerations (e.g., "regression to the mean", temporal trends). However, the significant differences detected in this study of 70 subjects are encouraging. While using such an analysis as a post-hoc justification for sizing a proposed study is not preferred, this benchmark is reasonable given the common source populations and outcomes.

Symptoms

Self-reported frequency of symptoms or objective measures of lung function have been the most common outcomes used in asthma studies. Symptom frequency is most commonly captured as "Symptom days" or "Symptom-free days", derived from the number of days within a specific timeframe (usually two weeks) that the subject experiences (or is free from) characteristic symptoms, such as wheezing, coughing, nighttime awakening, or shortness of breath. A cohort of 200 subjects would be capable of detecting a difference of 0.46 symptom days/week, assuming a power of 80 percent. (assumes a standard deviation of 1.3 symptom days per week)

Lung function measures include FEV1 (forced expiratory volume in one second), forced vital capacity, and mean morning and evening peak flow rates. These measures, while frequently employed in clinical trials, have not been as informative as the direct reporting of asthma-related symptoms, and require significantly more data collection.

Quality of Life Measures

The concept of "Quality of Life" has been applied to the analysis of health outcomes as a way to capture the day-to-day physical and emotional effects of chronic illnesses. For example, the Juniper Pediatric Asthma Quality of Life (PAQLQ) questionnaire evaluates QoL across three domains for both child and caregiver: symptoms, activity limitations and emotional function. Each domain is scored on a scale of 1 through 7; these domains are averaged to create a total PAQLQ score. (Juniper EF et al., 1996) Differences greater than 0.5 for this total score are considered clinically relevant.

Using data from a recent study of asthmatic children living in Boston public housing (Clougherty et al., 2006), where Juniper scores were taken at baseline (mean total score=4.86, standard deviation=1.36), we can estimate the sample size for the pilot study. In this case, a total sample size of 186 subjects (across both groups) would be required to detect a difference of 0.5 in Juniper scores, assuming a power of 80 percent. If the power were increased to 90 percent, the sample size would need to be increased to 256. (This calculation assumes that the difference between a randomized control and intervention group is being tested. A longitudinal analysis testing differences over time within sub-populations would require a different power calculation.)

Sample size - Conclusions

Based on these estimates, a minimum of 100 subjects should be enrolled into the pilot program, along with an equally-sized control population, either drawn from data collected by RIte Care health plans, or enrolled into a program that includes basic services without an in-home intervention. Obviously, budgetary and staffing limitations will dictate the size of this program, however, for a given number of intervention subjects, enriching the pool of "control" subjects can increase the study's power. In this

case, if healthcare utilization is the primary outcome, existing RIte Care databases can be used to define a control group.

All case management programs and research studies involving human subjects suffer some degree of attrition or "loss to follow-up." These losses may occur for many reasons, including participant re-location, subject disinterest or loss of health coverage. This issue can be addressed by enrolling additional subjects at baseline to account for the expected cumulative losses throughout the study period.

Proposed Design Structure

It is recommended that Rhode Island implement and sustain a model for in-home environmental case management that will provide education, as well as durable goods and services aimed at trigger mitigation in the home. Key tasks associated with program implementation are outlined below, along with design considerations.

- Convene stakeholders (e.g., RI Department of Health, RI Asthma Coalition, RIte Care Health Plans) across Rhode Island, building upon existing partnerships to:
  - Design necessary tracking systems
  - Specify the scope of program
    - Case definitions
    - Referral procedures
    - Educational materials
    - Scope of intervention services
  - Establish training model for staff
  - Address systemic issues across relevant agencies
  - Explore links between lead poisoning and asthma through analysis of available data
- Implement a pilot program that would provide in-home case management and services to remediate asthma triggers to 200 families, who will be tracked over a one-year period from the initiation of intervention. Of these families, 100 will receive an enhanced package of durable goods and services, based upon proven models employed in the Inner City Asthma Study. Both intervention groups will receive up to three home visits conducted by community health workers. During the initial home visit, a visual inspection will be performed to identify potential triggers. An individualized home intervention plan will be developed for each subject based on his or her risk profile.
- Interventions for the enhanced group will include additional goods and services. For each intervention, a decision matrix will be developed that utilizes information from each patient's medical history, diagnostic tests (e.g., skin prick, where available), survey data and environmental sampling to determine eligibility. Follow-up visits will track progress and provide additional education or assistance.

Table 6-2: Potential intervention activities by intensity level

Components	Basic	Enhanced*
In-home education and case management	✓	✓
Mattress + pillow covers	✓	✓
Pest management supplies (roach baits, rodent traps)	✓	✓
Smoking cessation (referral if covered)	✓	✓
HEPA vacuum	-	✓
HEPA air cleaner	-	✓
Integrated Pest Management program	-	✓
Home repairs	-	✓
Mold remediation	-	✓

* potential interventions are listed – for each subject, selection of components will be customized.

- As shown in Table 6-3, costs for more intensive interventions can be considerable. As stated above, existing studies have shown that effective programs can cost in excess of $1,500 per home, resulting in intervention costs in excess of $150k for a pilot program, as described above.

Table 6-3: *Approximate* Costs for Asthma-relevant Home Interventions

Intervention	Cost	Cost Variability
Mattress + pillow covers	< $100	Low
Air cleaner (HEPA)	$100-200	Low
HEPA vacuum	$100-200	Low
Smoking cessation	Up to $1000	Med
Food storage containers	< $50	Low
Mattress replacement	$300+	Low
Minor repairs	$200-$500	High
Mold/moisture remediation	$200+	High
Targeted repairs – pest access	$200+	High
Combustion appliances – removal/replacement	$500+	Med
Home cleaning	$200-$1000+	High
Integrated Pest Management contractor	$200-$1000+	High

- Subjects for the pilot program should be drawn from RIte Care membership. Drawing from a single health plan (e.g., Neighborhood) will likely ease implementation and facilitate tracking of claims.
- Similarly, building the pilot program from a single Lead Center will ease implementation, allowing for centralized staffing, training and management of intervention activities. Based on current caseloads at RI Lead Centers, additional staffing would be required to implement the pilot program. This staffing would, at a minimum, include 2-3 full-time positions. One of these positions should be filled with a person with, significant clinical experience, preferably in asthma case management. St. Joe's Lead Center is best equipped currently to manage an expanded program. The costs associated with this staffing increase will exceed $100k/yr.

For each additional 100 subjects/year, 2-3 full time staffers would be needed to support this caseload.

- Given projected reductions in caseloads at the Lead Centers, additional capacity will be available. According to HEALTH goals, the number of lead poisoned children (BLL>10μg/dL) may be reduced from 621 at the end of 2005 to 120 at the end of 2010.
- If budgetary restrictions do not allow for the enrollment and tracking of 200 subjects, interventions should be focused on a mix of 'basic' and 'enhanced' interventions for 100 families. A control population should be drawn from RIte Care membership, which would allow for the collection of utilization data. (Operationally, this could be accomplished by selecting 250 subjects from RIte Care membership and randomly assigning 125 subjects to receive interventions. The excess enrollment would allow for some loss to follow-up.)
- Assess effectiveness of the enhanced environmental intervention program through comparison of claims data, symptoms, quality of life and (potentially) allergen levels in the home.

Table 6-4: Estimated Effort Required for Asthma Intervention Pilot Program and Evaluation

	SCOPE OF EFFORT		
	Minimum	**Better**	**Best**
DESIGN			
Number of participants enrolled in program	100	100	200
Intervention design	**Intervention group** *Basic Intervention (n=100)* Home-based environmental interventions including clinical evaluations, environmental education, basic supplies and referrals to existing programs. (HEDIS-defined persistent asthmatics) **Control group** Claims data extracted for 100 controls (persistent asthmatics) drawn from RIte Care data within health plans. (no services provided)	**Intervention groups** *Enhanced Interventions (n=100)* Home-based environmental interventions including clinical evaluations, environmental education, basic supplies, referrals to existing programs., durable goods and contracted services. (HEDIS-defined persistent asthmatics) **Control group** Claims data extracted for 100 controls (persistent asthmatics) drawn from RIte Care data within health plans. (no services provided) NOTE: In addition, basic disease or case management services could be provided to an enrolled control group of 100, raising the number of participants to 200.	**Intervention groups** *Enhanced Interventions (n=100)* Home-based environmental interventions including clinical evaluations, environmental education, basic supplies, referrals to existing programs., durable goods and contracted services. (HEDIS-defined persistent asthmatics) *Basic Intervention (n=100)* Home-based environmental interventions including clinical evaluations, environmental education, basic supplies. **Control group** Claims data extracted for 100 controls (persistent asthmatics) drawn from RIte Care data within health plans. (no services provided)
Intervention options	In-home education Peak flow meters Mattress + pillow covers	In-home education Peak flow meters Mattress + pillow covers Pest management supplies Smoking cessation referral HEPA vacuum HEPA air cleaner Integrated Pest Management Mold remediation Basic home repairs	In-home education Peak flow meters Mattress + pillow covers Pest management supplies Smoking cessation referral HEPA vacuum HEPA air cleaner Integrated Pest Management Mold remediation Basic home repairs (+ more extensive repairs and remediation as needed)
Staffing*	Clinical (1) Staff (2)	Clinical (1) Staff (2)	Clinical (2) Staff (4)
Other options	-	Environmental Sampling (allergens in settled dust)	Environmental Sampling (allergens in settled dust)

*after year 1 of the program, this level of staffing would be sufficient to enroll and manage case loads of more than 100 subjects receiving basic case management services.

Table 6-5: Estimated Level of Effort/Cost for Asthma Pilot Program and Evaluation

LEVEL OF EFFORT/COST						
	Minimum		**Better**		**Best**	
Activity	**LOE** (person-months)	**Cost**	**LOE** (person-months)	**Cost**	**LOE** (person-months)	**Cost**
Preparation	3	$ 42,000	3	$ 42,000	4	$ 56,000
Database design	1.5	$ 16,500	1.5	$ 16,500	1.5	$ 16,500
Training	2	$ 34,000	2	$ 34,000	3	$ 51,000
Intervention (direct costs)	-	$10,000	-	$120,000	-	$130,000
Sampling	-	-	-	$ 16,000	-	$ 32,000
Staffing (Direct/ Indirect)	3 FTEs for 2 years	$ 420,000	3 FTEs for 3 years	$630,000	6 FTEs for 3 years	$ 1,260,000
Data analysis	2	$ 34,000	4	$ 68,000	4	$ 68,000
Program evaluation	2	$ 34,000	2	$ 34,000	2	$ 34,000
Total Cost	$ 590,500 over 2 years		$ 960,500 over 3 years		$ 1,647,500 over 3 years	

Cost Estimate Details

Preparation

Assumes significant in-kind contributions by staff and experts within Rhode Island agencies and key partners, including RIte Care health plans. In conjunction with HEALTH staff and relevant partners, includes:

1) Establish Steering Committee
2) Establishing Case Definitions and Source Population
3) Development of Screening Tools/Forms
    - Surveys/Tracking/Links to RIte Care data, etc.
4) Program Design
    - Case Management framework/Medical Management
    - Home Visit Protocols
        - Visual Inspection Protocols
        - Environmental Sampling Methods
    - Protocol for return visits
    - Coordination with and utilization of existing programs (referrals)
    - Environmental interventions
        - Determination of Scope of Services
        - Design of decision matrix (Susceptibility-exposure links)

Estimate of effort and cost based on 50% effort for technical/clinical expert @ $125/hour and 50% effort for technical staff @ $50/hour.

Database design

Design of program database structure to inform continued program evaluation, including: overall structure, data entry procedures, coordination with external data sources (e.g., RIte Care health plans), tracking systems and quality assurance/quality control procedures.

Estimate of effort and cost based on 25% effort for technical/clinical expert @ $125/hour and 75% effort for technical staff @ $50/hour.

Training

Training of clinical and field staff on (1) asthma pathophysiology, etiology, diagnosis and treatment; (2) basics of "healthy homes" issues; (3) methods to identify, mitigate and monitor environmental hazards in the home, especially asthma triggers; (4) social work model of identifying and connecting patients to needed services; and (5) basics of case management.

Estimate of effort and cost based on 75% effort for technical/clinical experts @ $125/hour and 25% effort for technical staff @ $50/hour.

Interventions

For those receiving more than basic education and supplies, each intervention will be customized based on home conditions, exposures, susceptibility and costs (see some examples in Table 1). Most likely a cap on services and costs would be established.

Minimum ~$100 in goods/member; assumed mean of $100; 100 * $100 = $10,000
Better $300 -$2000+/member; assumed mean of $1,200; 100 * $1,200 = $120,000
Best Mix of 'minimum' and 'better'; 100*$100 + 100*$1200 = $130,000

Sampling

Minimum none
Better 100 homes * 2 samples/home (pre/post) * $80/sample = $ 16,000
Best 200 homes * 2 samples/home (pre/post) * $80/sample = $ 32,000

Analyses include minimum of 3 key allergens (cockroach, mouse, dust mite).

Staffing

As above, assumes significant in-kind contributions by staff and experts within Rhode Island agencies and key partners, including RIte Care health plans. Additional staffing would be required as follows:

Clinical staff	Person(s) with clinical asthma case management experience; bilingual (e.g., for 'minimal' or 'better', 1 FTE @ 100% effort)
Field staff	Bilingual Community Health Workers (CHW) (e.g., for 'minimal' or 'better', 2 FTE @ 100% effort)
Salaries	Assumes $60k/year for clinical position and $40k/year for CHWs, plus 50% fringe rate (no cost of living adjustments; no indirect costs).

Data Analysis

Data analysis will become more complicated as number of data sources and types of data requiring cleaning and analysis are increased.

Program Evaluation

Evaluation of program's cost effectiveness and efficacy of environmental interventions to reduce asthma morbidity, as compared with traditional clinical interventions; evaluation of associated costs and benefits, including the incremental benefits of more intensive efforts; and account for other potential influences on changes in health outcomes. Report preparation.

Table 6-6: Approximate Costs for Supplies and Services Associated with Potential Home Interventions

Intervention	Cost	Variability
MINIMAL		
Educational materials	<$20	Low
Peak flow meters	<$30	Low
Mattress + pillow covers	$100*	Low
Food storage containers	<$50	Low
ENHANCED		
Air cleaner (HEPA)	$100-200	Low
HEPA vacuum	$100-200	Low
Smoking cessation	Up to $1000*	Medium
Mattress replacement	$300+	Low
Minor repairs	$200-$500	High
Mold/moisture remediation	$200+	High
Targeted repairs – pest access	$200+	High
Combustion appliances – removal/replacement	$500+	Med
Home cleaning	$200-$1000+	High
Integrated Pest Management contractor	$200-$1000+	High
Major home repairs	$1000+	High

*potentially covered under RIte Care

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APPENDIX A

RHODE ISLAND LEAD CENTERS CASE LOADS, 2006

Healthy Homes
Healthy Children

Number of cases referred to each lead center in 2006

Insurance	Total	Blackstone	%	East Bay	%	St. Joseph	%	Westbay	%
Blue Cross	22	5	9%	1	25%	13	11%	3	11%
Blue Cross Rightcare	1	1	2%		0%		0%		0%
Neighborhood Health Care	101	29	52%	1	25%	61	50%	10	37%
Other	41	11	20%	1	25%	23	19%	6	22%
United Health Care	29	7	13%		0%	17	14%	5	19%
United Health Care Rite Care	14	3	5%	1	25%	7	6%	3	11%
Total	208	56	100%	4	100%	121	100%	27	100%

-Blackstone: Blackstone Valley Community Action Program - St. Joseph: St. Joseph Hospital Lead Safe Center
-East Bay: East Bay Community Action Program -Westbay: Westbay Community Action Program.

Lead Center	% Cases with RiteCare	% Cases with Non RiteCare
Blackstone Valley Community Action Program	59%	41%
East Bay Community Action Program	50%	50%
St. Joseph Hospital Lead Safe Center	56%	44%
Westbay Community Action Program	48%	52%
	56% Cases with RiteCare	**44% Cases with Non RiteCare**

Blackstone Valley Community Action Program, 2006

MinCaseType	# of Cases Open	# of Cases Referred	% Cases Open
EBLCHILD	22	26	85%
PERSISTEBL	5	5	100%
PREVENTIV	21	25	84%
Total	48	56	86%

St. Joseph Hospital Lead Safe Center, 2006

MinCaseType	# of Cases Open	# of Cases Referred	%Cases Open
EBLCHILD	49	52	94%
PERSISTEBL	5	6	83%
PREVENTIV	51	63	81%
Total	105	121	87%

Westbay Community Action Program, 2006

MinCaseType	# of Cases Open	# of Cases Referred	% Cases Open
EBLCHILD	9	10	90%
PERSISTEBL	1	1	100%
PREVENTIV	11	16	69%
Total	21	27	78%

East Bay Community Action Program, 2006

MinCaseType	# of Cases Open	# of Cases Referred	% Cases Open
EBLCHILD	2	2	100%
PERSISTEBL	0	0	100%
PREVENTIV	2	2	100%
Total	4	4	100%

Created by HEALTH/RI/Khanh Truong
Source: RI Dept of Health, CLPPP, LESS database

APPENDIX B

CHRONOLOGY OF PROJECT-RELATED MEETINGS AND CONFERENCE CALLS WITH STAKEHOLDERS

Chronology of Project-related Meetings and Conference Calls with Stakeholders

Date	Activity
08/09/2006	Conference Call with Blue Cross/Blue Shield
08/29/2006	Conference Call United Health Care
09/20/2006	In-person meetings (Providence, RI) with St. Joseph's Hospital Lead Center Blackstone Valley, WestBay, and EastBay Lead Centers
10/05/2006	In-person meetings (Providence, RI) with United Health Care and Blue Cross/Blue Shield
10/12/2006	Phone call with Neighborhood Health Plan
11/17/2006	Phone call with Neighborhood Health Plan
04/12/2007	Conference Call with Rhode Island DHS/Medicaid
04/13/2007	Conference Call with St. Joseph's Lead Center

APPENDIX C

ADDITIONAL RESOURCES

Guide to Additional Resources

National Reports

U.S. Department of Housing and Urban Development (HUD). (2006). Healthy homes issues: Asthma. Washington, D.C.: HUD Office of Healthy Homes and Lead Hazard Control.

Institute of Medicine (U.S.) Committee on the Assessment of Asthma and Indoor Air. (2000). *Clearing the air: Asthma and indoor air exposures*. Washington, D.C.: National Academy Press.

National Asthma Education & Prevention Program. (2002). *Expert panel report: Guidelines for the diagnosis and management of asthma. Update on selected topics 2002* (No. 02-5074). Bethesda, MD: U.S. Department of Health and Human Services, National Institute of Health, National Heart, Lung and Blood Institute.

National Asthma Education & Prevention Program. (1997). *Expert panel report 2. Guidelines for the diagnosis and management of asthma* (No. 97-4051). Bethesda, MD: U.S. Department of Health and Human Services, National Institutes of Health, National Heart Lung and Blood Institute.

National Environmental Education & Training Foundation (NEETF). (2005). *Environmental management of pediatric asthma: Guidelines for health care providers*. Washington, D.C.

State Reports

Rhode Island Department of Health. (2004). *Asthma in Rhode Island*. Providence.

Rhode Island Department of Health. (2006). *Childhood lead poisoning in Rhode Island: The numbers 2006 edition*. Providence: Rhode Island Childhood Lead Poisoning Prevention Program.

Rhode Island Department of Health. (2003). *Evaluation of case management for lead poisoning in Rhode Island*. Providence: Rhode Island Childhood Lead Poisoning Prevention Program.

Rhode Island Department of Health. (2007). *Healthy housing: Why Rhode Island should invest in the vision*. Providence: Rhode Island Childhood Lead Poisoning Prevention Program, Healthy Housing Collaborative.

Rhode Island Department of Health. *Partners in asthma control for Rhode Island: Strategies for addressing asthma issues in Rhode Island*. Providence.

Guide to Additional Resources (cont.)

Asthma Regional Council (ARC)

Adams, M. (2006). *The burden of asthma in New England*. Dorchester: Asthma Regional Council (ARC).

Hoppin, P., & Donahue, S. (2004). *Improving asthma management by addressing environmental triggers: Challenges and opportunities for delivery and financing*. Dorchester: Asthma Regional Council of New England (ARC).

Hoppin, P., Jacobs, M., & Ribble, M. (2006). *Enhancing asthma management using in-home environmental interventions: A review of public health department programs*. Dorchester: Asthma Regional Council of New England (ARC).

Hoppin, P., Jacobs, M., & Stillman, L. (2007). *Investing in best practices for asthma: A business case for education and environmental interventions*. Dorchester: Asthma Regional Council of New England (ARC), University of Massachusetts Lowell, Childrens Hospital Boston.

APPENDIX D

DATA REQUEST TO RITE CARE HEALTH PLANS

To: Gilson DeSilva, Blue Cross/Blue Shield of Rhode Island
Dorothy Erickson, Neighborhood Health Plan
Jeanne Gibree, United Health Plan
From: Gary Adamkiewicz, Adrienne Ettinger
Harvard School of Public Health (617) 384-8852
CC: Ruth Lindberg, Rhode Island Department of Health

Date: October 30, 2006

RE: Detailed Data Request for RIte Care Health Plans – AHRQ Project to Evaluate the Feasibility of Environmental Interventions for Asthma in Rhode Island

Thanks to all of you for the time you have given over the past few weeks, both in person and on the phone, working with us on our project to evaluate the feasibility of environmental interventions for asthma in Rhode Island. Based on these discussions and the goals of our project, we would like to have sufficient data to describe the following:

- trends in RIte Care membership over the past five years
- trends in number of members with persistent asthma
- trends in asthma claims for members with persistent asthma (total numbers and costs)
- trends in number of members with any primary asthma diagnosis
- trends in all asthma-related claims (total numbers and cost)
- trends in asthma-related prescriptions (total numbers and costs)

Attached is a detailed request for the data needed from each health plan to describe these trends, including the instructions to follow in this document (with relevant time periods and case definitions) and an Excel workbook with 7 worksheets of data entry tables in which to fill in the requested information. We have distinguished between total and continuous enrollment since 'churn' is a problem within the RIte Care membership pool.

We hope that this is a useful way to organize our request and understand that you may not have the data available for all of the years or items requested. Please attempt to complete all of the worksheets with the available data for your plan.

In addition to the detailed information requested, we would like to obtain some information regarding any internal evaluations of your existing asthma case management programs. If you have this type of information available, please also forward any relevant reports or evaluation summaries to us.

We would like to have this information from you in three weeks, by **Monday, November 20, 2006** (before Thanksgiving and the holidays are upon us). If this is not possible, please contact us directly. Also, please do not hesitate to contact us for clarification or with any other questions related to this request.

Thanks again for taking the time to help us with this important project.

INSERT NAME OF HEALTH PLAN HERE

TRENDS IN MEMBER DEMOGRAPHICS

TOTAL ENROLLMENT

Member Demographics, By Year (All Ages)

Year	Total Enrollment	Total Enrollment, By Age Group					
	All Ages	0-4	5-9	10-17	18-56	56+
2001							
2002							
2003							
2004							
2005							
2006*							

* Include calendar year 2006 data (01/01/06 - 06/30/06)

Member Demographics, By Year and Core City (Children Age 0-17)

Year	Total Enrollment (Children)	Total Enrollment (Children Age 0-17), By Core Cities						
	All Cities	Central Falls	Newport	Pawtucket	Providence	West Warwick	Woonsocket	All Other
2001								
2002								
2003								
2004								
2005								
2006*								

* Include calendar year 2006 data (01/01/06 - 06/30/06)

Member Demographics, By Year and Core City (Adults Age 18+)

Year	Total Enrollment (Adults)	Total Enrollment (Adults Age 18+), By Core Cities						
	All Cities	Central Falls	Newport	Pawtucket	Providence	West Warwick	Woonsocket	All Other
2001								
2002								
2003								
2004								
2005								
2006*								

* Include calendar year 2006 data (01/01/06 - 06/30/06)

CONTINUOUSLY-ENROLLED MEMBERS

Member Demographics, By Year (All Ages)

Year	Continuously Enrolled	Continuously-Enrolled Members, By Age Groups					
	All Ages	0-4	5-9	10-17	18-56	56+
2001							
2002							
2003							
2004							
2005							
2006*							

* Include calendar year 2006 data (01/01/06 - 06/30/06)

Member Demographics, By Year and Core City (Children Age 0-17)

Year	Continuously Enrolled (Children)	Continuously-Enrolled Members (Children Age 0-17), By Core Cities						
	All Cities	Central Falls	Newport	Pawtucket	Providence	West Warwick	Woonsocket	All Other
2001								
2002								
2003								
2004								
2005								
2006*								

* Include calendar year 2006 data (01/01/06 - 06/30/06)

Member Demographics, By Year and Core City (Adults Age 18+)

Year	Continuously Enrolled (Adults)	Continuously-Enrolled Members (Adults Age 18+), By Core Cities						
	All Cities	Central Falls	Newport	Pawtucket	Providence	West Warwick	Woonsocket	All Other
2001								
2002								
2003								
2004								
2005								
2006*								

* Include calendar year 2006 data (01/01/06 - 06/30/06)

APPENDIX E

Rhode Island Agency for Healthcare Research and Quality (AHRQ) Team Members

Rhode Island AHRQ Team Members
February 2007

Halima Ahmadi
Asthma Control Program
RI Department of HEALTH

Jackie Ascrizzi
RI Department of Education

Melissa Barie
Lead Center Program
RI Department of Health

Carrie Bridges
Office of Minority Health
RI Department of Health

Chris Camillo
Community Asthma Programs
Hasbro Children's Hospital

Rosanna Castro
Office of Family Outreach Program
RI Department of Health

Deborah Garneau
Office of Special Health Care Needs
RI Department of Health

Debbie Justa
Neighborhood Health Plan of RI

David King
Blue Cross Blue Shield of RI

Robert Klein, MD
Asthma and Allergy Center
Hasbro Children's Hospital

Sharanya Krishnan
Diabetes Prevention and Control Program
RI Department of Health

Lisa LeTang
RI Parent Information Network/Community
Asthma Program
Hasbro Children's Hospital

Ray Neirinckx
RI Housing Resource Commission
RI Department of Administration

Deborah Pearlman, PhD
Asthma Control Program
RI Department of Health

Tina Ragless
American Lung Association of RI

Amy Rainone
RI Housing

Nancy Sutton, MS, RD
Asthma Control Program
RI Department of Health

APPENDIX F

Rhode Island Asthma Control Coalition Members

Rhode Island Asthma Control Coalition

Member Name	Organization
Jackie Ascrizzi	RI Department of Education
Irma Barrios	Progresso Latino
Eugene Benoit	EPA, Region 1
Stanley Block	Providence Community Health Centers
Helen Bradshaw	Warwick School Department
Carrie Bridges	RI Department of Health, Office of Minority Health
Cindy Brosnan	Hasbro Children's Hospital, Asthma & Allergy Center
Maureen Brousseau	Neighborhood Health Plan of RI
Chris Camillo	Hasbro Children's Hospital, Asthma & Allergy Center
Carolyn Campos	CHisPA
Jim Celenza	RI Committee of Occupational Safety and Health
Amy Chaves	
Molly Clark	American Lung Association of RI
Kevin Connors	Women & Infants' Hospital
Jeanne D'Agostino	
Rosa DeCastillo	Lifespan, Community Health Services
Sorrel Devine	Providence Housing Authority
Seema Dixit	RI Department of Health, Tobacco Control
Brenda Drury	
David Ettensohn	
Debra Foley	Worksite Wellness Council
Nancy Fritz	Genesis Center
Deborah Garneau	RI Department of Health, Office of Children w/ Special Needs
Nancy Harrison	Neighborhood Health Plan of RI
Joanne Jacobs	Community College of RI
Jim Sattel	East Bay Community Action Program
Rhona Julien	EPA, Region 1
Cathy Kempe	
David King	Blue Cross Blue Shield of RI
Karim Khanbhai	Children's Choice Pediatrics
Robert Klein	Hasbro Children's Hospital, Asthma & Allergy Center
Sharanya Krishnan	RI Department of Health, Diabetes Prevention & Control
Lisa LeTang	Hasbro Children's Hospital, Asthma & Allergy Center
Sheila Linehan	UnitedHealthcare of New England
Jayne Matoian	

Member Name	Organization
Kate McCarthy-Barnett	RI Department of Health, Disability and Health
Elizabeth McQuaid	Hasbro Children's Hospital, Asthma & Allergy Center
Linda Mendonca	Pawtucket School Department
Judy Morris	Providence Community Health Centers
Raymond Neirinckx	RI Department of Administration, Housing Commission
Kelly Orr	University of RI, School of Pharmacy
Virginia Paine	RI Department of Health, Adult Immunization
Deborah Pearlman	RI Department of Health, Asthma Control
Gina Policelli	City of Warwick, Tobacco Program
Tina Ragless	American Lung Association of RI
Kathy Rebeiro	Women & Infants' Hospital
Sheila Quinn	Women & Infants Hospital
Debbie Rainha	Neighborhood Health Plan of RI
Amy Rainone	RI Housing
Rosemary Reilly-Chammat	RI Department of Health, Family, Youth, and School Success
Jeffrey Seyler	American Lund Association, Southern NE Region
Peter Simon	RI Department of Health, Divisions of Family Health and Community Health & Equity
Marybeth Smuts	EPA, Region 1
Fred Sneesby	Providence Housing Authority
Nancy Sutton (Staff)	RI Department of Health, Asthma Control
Robert Trachtenberg	RI Area Health Education Centers
June Tourangeau	St. Joseph's Hospital
Arelis Valerio	Hasbro Children's Hospital, Asthma & Allergy Center
Robert Vanderslice	RI Department of Health, Environmental Health
Marsha Weiss	Lifespan, Community Health Services